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AMERICAN
DYESTUFF REPORTER

Devoted to Textile Chemistry
BLEACHING • DYEING • PRINTING • FINISHING

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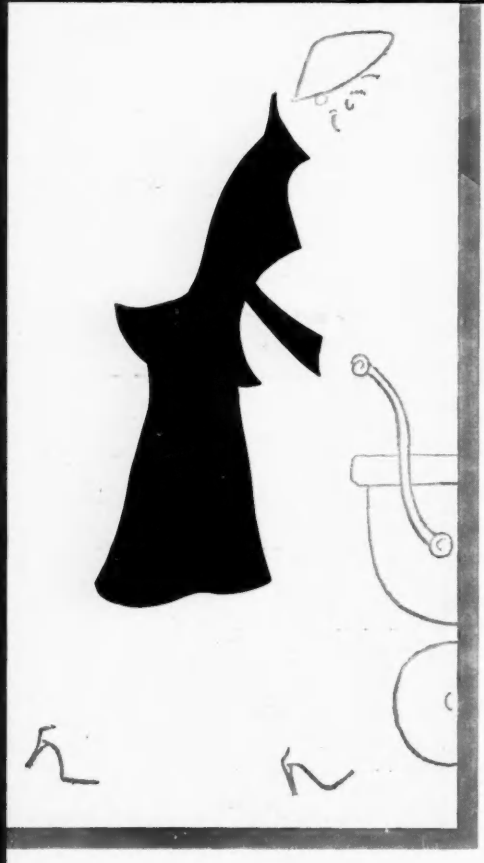
for "blues in the light"...
a direct dye for cotton and rayon

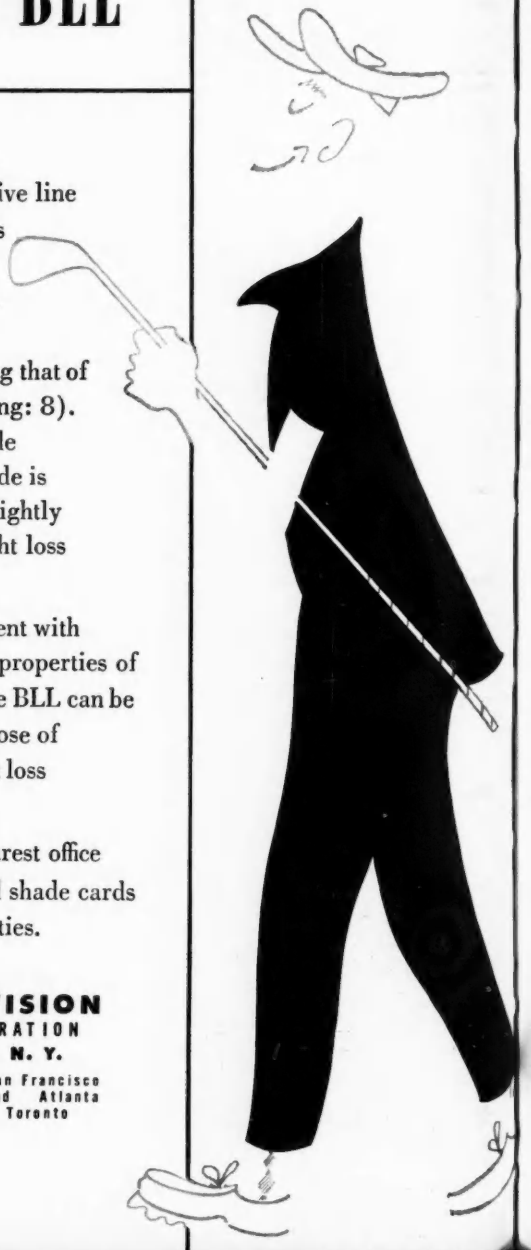
National Solantine Blue BLL



This recent addition to National's comprehensive line of direct dyes produces reddish shades of moderately bright blue with light fastness in full shades approaching that of vat dyes (AATCC Rating: 8). With urea-formaldehyde after-treatment, the shade is brightened and made slightly greener but with a slight loss in light fastness.

By simple after-treatment with Naccufix, wet fastness properties of National Solantine Blue BLL can be made comparable to those of developed dyes without loss of light fastness.

Write or phone our nearest office for samples, prices and shade cards giving complete properties.



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40 RECTOR STREET, NEW YORK 6, N. Y.

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Proceedings of the

American Association of Textile Chemists and Colorists

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Editor of Proceedings: Carl Z Draves, 30 Lahey St, New Hyde Park, N Y

SEPTEMBER 27, 1954

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*AATCC Research Newsletter No. 16

NEWS IN GENERAL

Highlighting this month's news is the announcement, made at the Atlanta Convention by National Corporate Membership Chairman Al Johnson, of a year-long campaign to increase corporate membership income to $72,000 and double the number of members. A carefully worked-out plan of membership extention has been installed to facilitate a much wider approach to industry for its support. Assistant Secretary Dick Frey is handling details of the campaign. Treasurer Albert Sampson revealed the need for additional revenue in pointing up the fact that, in the fiscal year ending last July 21, research costs exceeded corporate membership income by nearly $10,000. On top of this are the requirements for an even larger research budget for the coming year. The success of the campaign will depend very largely upon the co-operation of nearly 200 active individual members who have been asked to help, i e, the members of the Council, TCR and ECR, chairmen of all research committees, national and sectional officers, and members of the Corporate Membership Committee itself. Progress reports will be made through the Corporate Campaigner, a newsletter of the CM Committee. Two issues of the latter have already been published.

The American Standards Association has invited AATCC co-operation in the development of standard test procedures for evaluating the effect of textiles on human skin. The proposal stems from a request made to ASA by several insurance companies, which have expressed the hope that some standard means can be developed for evaluating damage claims in cases of dermatitis suspected of textile origin. Although the types of test procedure involved in the proposal are somewhat afield of the accepted aims of AATCC, the thought has been that a joint committee might well be set up with the American Medical Society to work with ASA and other interested associations. The matter is presently under consideration by ECR.

AT RESEARCH HEADQUARTERS

Harold Steigler, AATCC Director of Research, has advised that 41 AATCC-developed Accelorotors are now in use in a number of outstanding research laboratories both here and abroad. Several of the more interesting types of results obtainable with this instrument were on display in Atlanta, attracting very wide attention from the more than 1600 visitors attending the convention. Present work with the device includes an investigation of a new type abrasive liner using a sponge-rubber base.

COMMITTEE NEWS

The next quarterly meetings of the Council and research committees will be held November 18 and 19 in New York. Notices of the meetings will be mailed as soon as hotel accommodations have been arranged by ADR editor Norman Johnson. AATCC has long looked to Norman for help in negotiating its New York meeting requirements.

The Technical Committee on Research suffered a last-minute cancellation of its meeting scheduled at the Atlanta convention because of conflicts with other meetings and interests. The research committee reports that were to be heard at that time have been held over to the November 19 session. Chairman Chas Dorn states that TCR is not likely to attempt another convention meeting unless suitable arrangements can be made and considerable individual interest therein is indicated.

The Executive Committee on Research has named Eugene W K Schwarz to head up a new committee for the co-ordination of intersectional research interests and activities. Dr Schwartz has long advocated an effort to resolve some of the problems growing out of the wide geographical dispersion of AATCC Sections in the organization of research committee projects. Dr Schwartz has undertaken an important but intricate assignment, but he has the full backing of ECR in its accomplishment.

Another new committee, to be headed by TCR assistant chairman Chas A Sylvester, will undertake to co-ordinate AATCC's program on standard test fabrics. The committee will handle all problems relating to the production and distribution of AATCC-approved testing cloths, working closely with Dr Stiegler and producers.

*Published every other issue of the AMERICAN DYESTUFF REPORTER.

The October 11th issue of the DYESTUFF REPORTER will feature highlights of the 1954 Convention in Atlanta and will include fullest photographic coverage of the four-day event.

EMPLOYMENT REGISTER

This column is open for two insertions per year, per member, without charge. Blanks can be obtained from, and filed with, the Secretary of the Association, Lowell Technological Institute, Lowell, Mass. It is understood that these will be open to inspection by prospective employers who can obtain further information from the Secretary.

54-20

Education: BS, chemistry.
Experience: Head dyer and finisher, with executive experience in laboratory dyeing development.
Age: 46; married; references.
9-13, 9-27

54-22

Education: PhD, physical chemistry.
Experience: Research supervisor and chief chemist.
Age: 38; married; eastern US preferred.
9-27, 10-11

54-23

Education: BS, chemistry.
Experience: Textile chemist and engineer.
Age: 37; married; references; position as technical service representative or textile chemist desired, eastern US.
9-27, 10-11

54-24

Education: BTC, textile chemistry & dyeing.
Experience: Dyestuff salesman & demonstrator, head of branch office now closed.
Age: 41; married; references; New England preferred but not essential.
9-27, 10-11

Buttons bearing the insignia of the AATCC are available from the Secretary at a price of $2.25. Pins, with safety clasp, are also available at $2.50 each. Write directly to H C Chapin, AATCC Secretary, Lowell Technological Institute, Lowell, Mass.

AATCC CALENDAR

(A general calendar of events may be found on page 674)

COUNCIL
1954—Nov 19
1955—Jan 21, Apr 15, June 17

NATIONAL CONVENTIONS
Sept 21-23, 1955 (Chalfonte-Haddon Hall, Atlantic City, N J; 1956 (Waldorf-Astoria, New York); 1957 (Boston).

NEW YORK SECTION
October 15, November 19 (Kohler's Swiss Chalet, Rochelle Park, N J); January 28 (Georgian Room, Hotel Statler, New York); February 25 (Skytop, Hotel Statler, New York); March 18, April 22, May 20 (Kohler's Swiss Chalet, Rochelle Park, N J).

NORTHERN NEW ENGLAND SECTION
Oct 8 (Colonial C C, Lynnfield, Mass); Dec 10 (Woodland Golf Club, Auburndale, Mass).

PACIFIC SOUTHWEST SECTION
Oct 30 (Outing—Ojai, Calif)

PIEDMONT SECTION
Oct 16 (Hotel Barringer, Charlotte, N C).

PHILADELPHIA SECTION
Oct 29 (Penn-Sherwood Hotel, Philadelphia, Pa); Dec 3 (Kugler's Restaurant, Philadelphia).

RHODE ISLAND SECTION
Oct 14 (Johnson's Dummocks Grille, Providence, R I); Dec 2 (Annual Meeting —Sheraton Biltmore, Providence, R I).

SOUTH CENTRAL SECTION
Dec 4 (Hotel Patten, Chattanooga).

SOUTHEASTERN SECTION
Dec 11 (Atlanta-Biltmore, Atlanta, Ga).

WASHINGTON SECTION
Oct 1 (National Bureau of Standards, Washington); Dec 8 (Pepco Auditorium, Washington); Feb 11 (Washington); May 20.

WESTERN NEW ENGLAND SECTION
Oct 1, Nov 12, Dec 10 (Rapp's Restaurant, Shelton, Conn).

WESTERN NEW YORK SECTION
Oct 8 (Buffalo, N Y); Nov 27 (Hamilton, Ont); Jan 14 (Buffalo); Mar 4 (Hamilton, Ont); April 22 (Buffalo); June 24 (Outing)

Membership Applications

September 10, 1954

SENIOR

Charles E Fuller—Fabric designer, Jantzen Inc (Tech of Knitted Fabric Dev), Portland, Ore. Sponsors: C E Bouthillier, E B Brearley.

George R Griffin — Chairman, Div of Chemistry, Lowell Tech Inst, Lowell, Mass. Sponsors: J H Skinkle, H C Chapin.

Robert L Hunter—Sales service repres, Textile Fibers Dept, E I duPont de Nemours & Co, Inc, Wilmington, Del. Sponsors: B F Faris, R E Ritter.

Charles N Kuzma, Jr—Research chemist, Amalgamated Chemical Corp, Philadelphia, Pa. Sponsors: H B Dohner, J W Jordan.

JUNIOR

George Dominguez — Purchasing Dept, Geigy Dyestuffs Div, Geigy Chemical Corp, New York, N Y. Sponsors: E A Moggio, D P Knowland.

ASSOCIATE

Kichro Akaza—President, Akaza Textile Industrial Co, Ltd, Kanazama, Japan.

Claus W Busch, Jr — Assistant finisher, United Piece Dye Works, North Charleston, S C.

K Numajiri—Chief director, Japan Wool Products Inspection Inst Foundation, Tokyo, Japan.

David C Porter—Director, research & development, Eaton Chemical & Dyestuff Co, Detroit, Mich.

Teh H Wang — Director, China United Chemical Corp Ltd, Hong Kong.

September 13, 1954

SENIOR

Everett K McMahon—Mgr Tech Sales Development, Tennessee Prod & Chem Corp, Nashville, Tenn. Sponsors: J L Taylor, H A Dickert.

James Sands—Mgr Text Chem Sales Div, American Viscose Corp, Philadelphia 3, Pa. Sponsors: J P Hollihan, B N Baer.

APPLICATION FOR TRANSFER TO SENIOR MEMBERSHIP

William Wald, Jr

PERKIN CENTENNIAL COMMITTEE APPOINTMENTS

THE following chairmen have been appointed to head various subcommittees of the General Committee for the Perkin Centennial in 1956:

DINING AND BANQUET——George L Baxter, Bradford Dyeing Assoc

EDUCATIONAL——W George Parks, Univ of Rhode Island

ENTERTAINMENT —— Charles A Whitehead, Howes Publishing Co, Inc

EXHIBITS —— Henry L Young, Interchemical Corp

GENERAL PROGRAM——George O Linberg, Synthron, Inc

LADIES——Herman E Hager

PRINTING——Robert J Hamilton, General Aniline & Film Corp

PUBLICITY——Ansco G Brunier, Jr, E I du Pont de Nemours & Co, Inc

REGISTRATION AND RESERVATIONS —— Patrick J Kennedy, E I du Pont de Nemours & Co, Inc

TECHNICAL PROGRAM —— Walter M Scott, Bureau of Agriculture and Industrial Chemistry, U S Dept of Agriculture

1954 ADR AWARD PRESENTED TO CHARLES L ZIMMERMAN

THE fourth annual presentation of the AMERICAN DYESTUFF REPORTER Award has been made to Charles L Zimmerman, technical representative for American Cyanamid Company's textile resin department, for his paper, "The Application of Dyes to Textile Fibers at High Temperatures," which was published in the September 14, 1953 issue. The paper was presented at a meeting of the New York Section on April 17, 1953. Judges for the Award were John N Dalton, Pacific Mills, *chairman;* Alfred R Macormac, Agricultural Research Center; and James D Dean, retired. The Award was presented during the annual banquet at the Atlanta national convention on September 18th by Prof Percival Theel of Philadelphia Textile Institute, chairman of the AATCC publications committee.

Mr Zimmerman, a native of South Carolina, was graduated from The Citadel in 1934 with a BS degree in chemistry. He received his MS degree from Georgia Institute of Technology in 1942 and has done graduate work at Clemson College, Rutgers University and Brooklyn Polytechnic Institute. After teaching high school for one year in South Carolina he became plant chemist for Renfrew Bleachery in Travelers Rest, S C, in 1936 and in 1939 joined the United States Department of Agriculture, Bureau of Plant Industry, in Charleston, S C, where he served as chemist at the plant breeding laboratory. In 1942 he became associated

C L Zimmerman

with American Cyanamid Company at its Bound Brook, N J, plant, serving as a research chemist in the application of dyes to textile materials. In 1952 he was in charge of research in the dyeing of synthetic fibers and the following year was appointed a group leader in the dyes research section. At the present time Mr Zimmerman is technical representative for American Cyanamid Company's textile resin department.

Mr Zimmerman, in association with others, is the author of numerous technical papers including "Determination of the Solubility of Dyes," "Laboratory Apparatus for Studying Continuous Dyeing," "A Laboratory Study of Padding," "Application of Dyes to New Synthetic Fibers," and "The Stabilization of Vat Dyes at Elevated Temperatures."

He is a member of the AATCC, ACS, and the British Society of Dyers and Colourists.

The AMERICAN DYESTUFF REPORTER Award is endowed by the Howes Publishing Company as a memorial to Alfred P Howes, Founder of the REPORTER. Its purpose is to encourage the presentation of the best possible papers before local and national meetings of the AATCC. The Award, $200 annually, is presented to the author or authors of the paper considered best in the opinion of the judges. Any technical paper presented before a local or national meeting of the Association and published in the *Proceedings* as they appear in the REPORTER is eligible with the following exceptions: intersectional contest papers, papers by employees of the AATCC, reports of work substantially subsidized by AATCC, or reports of research committees. It is a condition of eligibility that the paper have its first publication in the *Proceedings.* Previous winners and titles of papers were:

1951 — Drs Mason Hayek and Fred C Chromey, E I du Pont de Nemours & Co, Inc: "The Measurement of Static Electricity."

1952 — Charles J Lyle, Joseph J Iannarone and Dr Robert J Thomas, E I du Pont de Nemours & Co, Inc: "High-Temperature Dyeing of New Synthetic Fibers."

1953 — Dr Robert H Blaker, E I du Pont de Nemours & Co, Inc: "Principles of Copper Dyeing of Polyacrylonitrile Fibers: The Controlled Redox-Potential Method."

ACTIVITIES OF THE LOCAL SECTIONS

Pacific Northwest

THIRTY-FIVE members attended the annual outing of the Pacific Northwest Section on July 31st at the Mt Hood Golf and Country Club at Welches, Oregon, located in the Mt Hood recreational area near Portland.

The day's activities included the annual golf tournament, a putting contest, and a horseshoe pitching competition. Winners in the events were awarded attractive prizes, which were furnished by mills and the various supply houses in the area.

A short business meeting followed dinner and the awarding of prizes.

—♦ ♦—

Piedmont Section

THE Annual Meeting of the Piedmont Section will be held on October 16th at the Wm R Barringer Hotel, Charlotte, N C.

The program calls for a research meeting in the morning with Edward A Murray serving as chairman, an officer's luncheon at noon, an afternoon technical session, and the evening banquet, which will feature the installation of new officers for 1955 and the recognition of the Silver Anniversary of past chairman Dick Mitchell.

The following papers will be presented at the afternoon technical session: "Unique Properties of Cyanoethylated Cotton", by Jack Compton, technical director, Institute of Textile Technology; and "A New Chemical Composition for the Stabilization of Viscose Rayon" by Paul M Stam, assistant director of research, Dan River Mills.

—♦ ♦—

New York

FRANCIS S RICHARDSON, technical director of Waldrich Co, Delawanna, N J, will discuss "The Barotor and its Practical Application" at the meeting of the New York Section to be held on October 15th at Kohler's Swiss Chalet, Rochelle Park, N J. The initial installation of a Barotor was at the Waldrich plant and this will be the first opportunity to hear of its operation from a person who has used it on a production basis.

OUTING • PACIFIC NORTHWEST SECTION • JULY 31, 1954

(L to r): J Ayres, Du Pont; C Fieldhouse, Ciba; F Wilhelm, American Aniline; R Beaudoin, Geigy; W Marshall, American Cyanamid

"We're in for one!"

"Ringer!"

The Putting Contest

NOTICE TO SECRETARIES AND PUBLICITY CHAIRMEN OF LOCAL SECTIONS

Papers presented before local sections should be sent to Dr Carl Z Draves, Editor of the *Proceedings*, 30 Lahey Street, New York. Authors should provide two copies for this purpose.

Reports of local section meetings should be sent to the American Dyestuff Reporter with copies going to Dr H C Chapin, National Secretary.

Dates of meetings and advance notices of meetings should be sent to the American Dyestuff Reporter with copies also going to Dr Chapin. For publication in any particular issue, information should be in the office of the Reporter 17 days before the issuance date.

New York Section——

FACTORS AFFECTING THE ABSORPTION OF DISPERSE DYES BY "DACRON" POLYESTER FIBER FROM AQUEOUS BATHS*

J J IANNARONE, OLETA S LARSON and R J THOMAS

Technical Labratory, Organic Chemicals Dept, E I du Pont de Nemours & Co, Inc

The authors have experimentally studied the factors affecting the absorption of disperse (acetate-type) dyes by "Dacron" polyester fiber from baths in which orthophenylphenol was employed as the carrier. It was found that, for a fixed percentage of carrier on wt of fiber at 205-208°F or without a carrier at 250°F, dye absorption decreases with increase of dyeing volume. If the percentage of carrier is based on wt of solution, however, the absorption increases with increase of dyeing volume.

When disperse dyes are used in combination with "Dacron", each dye in the combination exhibits about the same distribution value between bath and fiber for the conditions involved as it does when applied alone. The rate of exhaustion of disperse dyes at 205-208°F apparently increases with an increase of carrier concn. Concns of 3 to 6 g per liter at 60:1 vol and 6 to 9 g per liter at 20:1 vol give optimum dye absorption without any serious adverse effect on the fiber.

The interesting claim is made by the authors that most disperse dyes are stable at 250°F and dye better at that temperature without a carrier than with orthophenylphenol or benzoic acid as carriers at 205-208°F.

INTRODUCTION AND HISTORICAL BACKGROUND

WITH the initiation of full-scale manufacture of "Dacron" at the Du Pont Company's Kinston, North Carolina Plant, and the resulting increased availability of this fiber, designers are utilizing its unique properties by introducing it into more and more constructions for various end uses. Since "Dacron" is a relatively new fiber, it is quite possible that there are many dyers who may not be too familiar with its dyeing characteristics. In order to obtain satisfactory coloration, it was necessary to develop techniques different from those used heretofore in dyeing other fibers. The purpose of this paper is to present certain fundamental aspects related to the dyeing of "Dacron."

Two methods of dyeing are in commercial use, viz:

1) Application of disperse dyes at temperatures of 200-212°F with the assistance of an aromatic swelling agent or carrier (*1, 2, 3*); and

2) Application of disperse dyes at elevated temperatures under pressure without the assistance of a carrier (*4*).

Although over a thousand chemical compounds have been evaluated as carriers, those being used commercially today fall into three categories:

1) aromatic carboxylic acids (e g, benzoic acid);

2) phenylphenols; and

3) chlorinated benzenes.

Benzoic acid is an excellent carrier in that it promotes a relatively high degree of dye exhaustion and leveling without adversely affecting light-fastness properties. However, because it is expensive, only a few processors are using it. The chlorinated benzenes are relatively low in cost but require care in their use because of the toxicological hazard involved. They are used to some degree in circulating equipment where this hazard is minimized. In view of this limited use, the chlorinated benzenes have not been evaluataed in the present studies. Since the phenylphenols are effective at much lower concentrations than benzoic acid, they present a more favorable cost picture (*5*). Also, under conditions of use, they are essentially nontoxic. Despite their adverse effect on the light fastness of some dyes, their use has increased considerably. The most popular carrier of this class is orthophenylphenol, which is conveniently obtained by acidification in the dyebath of its readily soluble sodium salt (Dowicide A).

The high-temperature dyeing of "Dacron" polyester fiber in the form of rawstock, top and yarn in pressurized circulating equipment is already an established procedure in many dye houses. Also, socks and sweaters are being dyed at elevated temperatures in pressurized rotary machines. It is believed that piece goods of open construction can be handled in the Burlington dyeing machine (*6*), and fabrics of various constructions can be dyed in the newly developed "Barotor" (*7, 8*).

In the course of the laboratory and mill dyeing of "Dacron," it has been noted that different variables significantly affect the absorption of disperse dyes. This paper will discuss the influence of temperature and time of dyeing, the nature and concentration of carrier, and the volume ratio on the absorption of dyes by the staple fiber. A secondary objective is to check the observation of Reith and Andres (*8*) that disperse dyes applied in combination to "Dacron" polyester fiber exhibit distributions between bath and fiber like those obtained when applied singly.

EXPERIMENTAL

LABORATORY DYEING APPARATUS———Apparatus similar to that illustrated in Figures 1 and 2 of the Philadelphia Section's 1949 Intersectional Contest Paper on high-temperature dyeing (*9*) was used for the major part of the laboratory investigation. In this work it was found preferable to eliminate the "Teflon" polytetrafluorethylene-resin form for holding the skeins.

The yarn and dye liquor were placed in the glass tubes at room temperature, the tubes were sealed with a gasket made of "Teflon" and inserted into the metal shield. The metal shield was placed in a rotating arm in the polyethylene glycol bath, which was at a temperature of approximately 80°F. Rotation was started, the temperature was raised over thirty minutes to that desired, and dyeing was continued for the required period of time. At the end of the dyeing cycle, the tubes were removed from the polyethylene glycol bath and cooled under running water.

* Presented by R J Thomas before the New York Section on February 26, 1954. Ms scbmitted by the Editor of Proceedings on August 10, 1954.

NOTE: The names "Acetamine", "Alkanol", "Ce'anthrene", "Dacron", "Latyl", and "Teflon", which appear in this article, are registered trademarks of E I du Pont de Nemours & Co, Inc, Wilmington, Del; the name "Dowicide" is a registered trade-mark of The Dow Chemical Co, Midland, Mich; and the name "Celliton" is a registered trade-mark of General Dyestuff Co, New York.

TABLE I

EFFECT OF DIFFERENT DYEBATHS ON APPLICATION PROPERTIES OF DISPERSE DYES IN DYEING STAPLE "DACRON" POLYESTER FIBER

		Grams dye absorbed/100 grams fiber				Percent transfer*			
		1 hour at 205-208°F			1 hour 250°F	1 hr at 205-208°F		1 hour 250°F	Stability at 250° F
Dye (2.0%)	Pr No.	no carrier***	20 g/l benzoic acid	3.0 g/l Dowicide A**	no carrier	20 g/l benzoic acid	3.0 g/l Dowicide A**	no carrier	% undecomposed
"Celanthrene" Fast Yellow GL Conc 300%	—	0.68	1.25	1.05	1.78	100	100	100	100
"Acetamine" Yellow N	—	0.79	1.68	1.65	1.72	80	70	80	95
"Acetamine" Fast Yellow 4RL	—	1.40	1.82	1.80	1.85	10	10	40	97
"Acetamine" Yellow CG	242	1.20	1.78	1.80	1.74	80	45	80	100
"Latyl" Yellow YL	—	0.78	1.80	1.88	1.78	40	50	100	98
"Latyl" Orange R	—	0.61	1.41	1.16	2.00	15	15	40	96
"Celanthrene" Red 3BN Conc	234	1.29	1.96	1.95	1.93	75	50	90	96
"Latyl" Red B	—	1.23	1.75	1.90	2.00	40	40	80	97
"Acetamine" Rubine B Conc 125%	238	1.20	1.98	1.97	1.92	25	20	90	92
"Acetamine" Scarlet B	244	1.06	1.66	1.66	1.95	45	40	45	99
"Celanthrene" Cerise B	—	1.50	2.00	2.00	1.95	75	50	100	100
"Celanthrene" Fast Pink 3B	235	0.58	1.32	1.01	1.25	75	25	75	100
"Latyl" Violet 2R	—	0.79	1.75	1.46	2.00	20	<10	90	100
"Latyl" Violet B	—	1.32	2.10	1.60	2.10	<10	<10	<10	96
"Latyl" Brilliant Blue 2G	—	0.56	1.20	0.99	1.33	15	15	40	86
"Latyl" Blue B	—	0.71	1.28	1.12	1.56	40	20	90	
"Latyl" Blue GE	—	0.30	1.68	1.36	1.85	10	<10	80	93
"Celanthrene" Brilliant Blue FFS Conc 200%	228	1.13	1.45	1.13	1.93	15	15	40	82

*A rating of 100% indicates that both skeins upon completion of test were equal in strength.
** Acidified to pH 5.3.
*** Rinsed in acetone at 40°F.

ABSORPTION, TRANSFER AND PENETRATION OF DISPERSE DYES——In earlier studies, quantitative data on the effect of elevated dyeing temperature on the absorption of a few disperse dyes by both filament and staple "Dacron" polyester fiber and the effect of benzoic acid on the absorption of disperse dyes by filament "Dacron" were reported (*4*). In this previous work a high concentration (8.0%) of dye was employed.

A broader survey has now been conducted in which dyeings were carried out on 2/26's w c yarn at a 20:1 volume in closed tubes with 2.0-per cent of dye on the weight of the fiber at 205-208°F without a carrier, with 20.0 g/l benzoic acid and with 3.0 g/l orthophenylphenol*, and at 250°F without a carrier. The dye absorption data in Table I show that not only are the cost and the hazards of a carrier eliminated by employing a dyeing temperature of 250°F, but also equal or improved dye absorption is realized as compared with that obtained with either carrier. This would indicate further that the stability of the disperse dyes at 250°F is good. In order to check this, 80 ml of control dispersion, prepared by pasting 1.00 gram of commercial dye with 1.0 gram "Alkanol" DW Solution surface-active agent and diluting to one liter with water, was treated for two hours at 250°F in the absence of fiber and cooled. A 10-ml aliquot portion was then diluted to 500 ml with a 65:35 mixture by volume of acetone and water. This solution was compared spectrally with an unheated control, which was made up in the same manner. Results which appear in Table I indicate that, in general, the disperse dyes possess good stability at 250°F. Although the effect of metals on dye stability has not been determined, no adverse effects have been reported as a result of dyeing in commercial equipment.

In addition to determining relative dye absorption and stability, transfer of the disperse dyes, when applied at 205-208°F with benzoic acid or orthophenylphenol as a carrier and at 250°F without a carrier, was investigated. Dyeings made as described above were introduced with an equal weight of undyed yarn into blank dyebaths (containing all reagents but no dye) and treated for one hour at the temperature at which dyeing had been carried out. Transfer from the dyed to the undyed skein was then visually rated. These results, which also appear in Table I, indicate that transfer at 250°F is at least equal and in some cases is considerably superior to that obtained at 205-208°F with either benzoic acid or orthophenylphenol.

In previous studies it was shown that the penetration of continuous-filament "Dacron" polyester fiber is essentially complete on application of disperse dyes for one hour at 250°F, partially complete on application for one hour at 212°F with 20 g/l benzoic acid and very slight on application for one hour at 212°F without the use of a carrier (*4*). In the present study, cross sections of staple-yarn dyeings of all of the products listed in Table I were examined to ascertain the degree of penetration by each method of application. In all cases the dyeings carried out at 250°F exhibited complete penetration, those carried out at 205-208°F with either 20 g/l benzoic acid or 3.0 g/l orthophenylphenol exhibited essentially complete penetration, and those carried out at 205-208°F without a carrier exhibited poor penetration.

RATES OF EXHAUSTION OF DISPERSE DYES——In the commercial dyeing of fabrics made of "Dacron" polyester fiber, little or no difficulty has been encountered in producing self-shade dyeings. However, most commercial dyeing involves compound shades, and, with certain specific dye combinations, unlevelness has occasionally resulted and has required prolonged treatment with the carrier for correction.

In order to minimize unlevelness, it is desirable to produce compound shades with dyes that exhaust at about the same rate. At times a limited range of dyes causes this consideration to become secondary to the requirements of shade and fastness. Although the latter has been the case in dyeing "Dacron" polyester fiber, it was considered of interest to obtain rate-of-absorption data, both from carrier dyebaths at 205-208°F and from baths at

* Throughout this paper the indicated concentrations of orthophenylphenol ($C_{12}H_9OH$) actually refer to the concentration of Dowicide A ($C_{12}H_9ONa.4H_2O$) from which the free orthophenylphenol was derived on acidification without buffering to pH 5.3. (Concn of Dowicide A x 0.644 = concn of orthophenylphenol.)

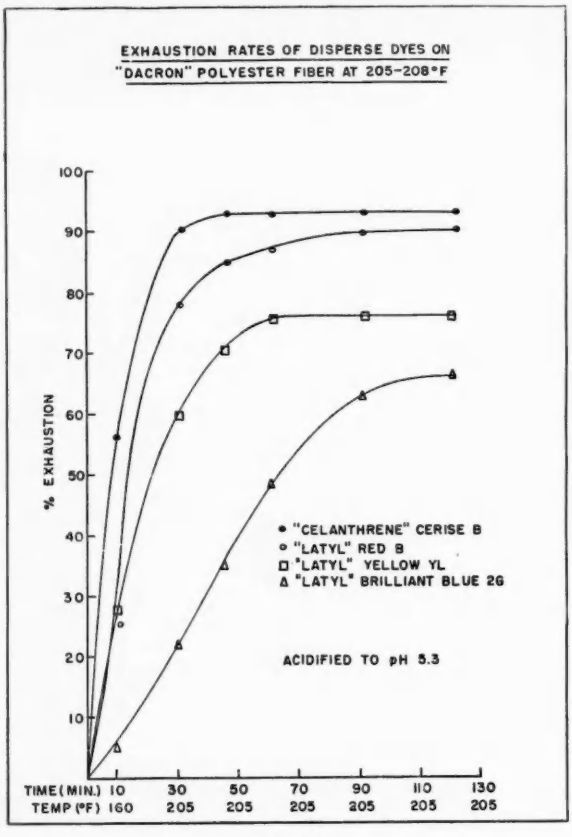

Figure 1
(1% dye; 3.0 g/l Dowicide A; 20:1 volume)

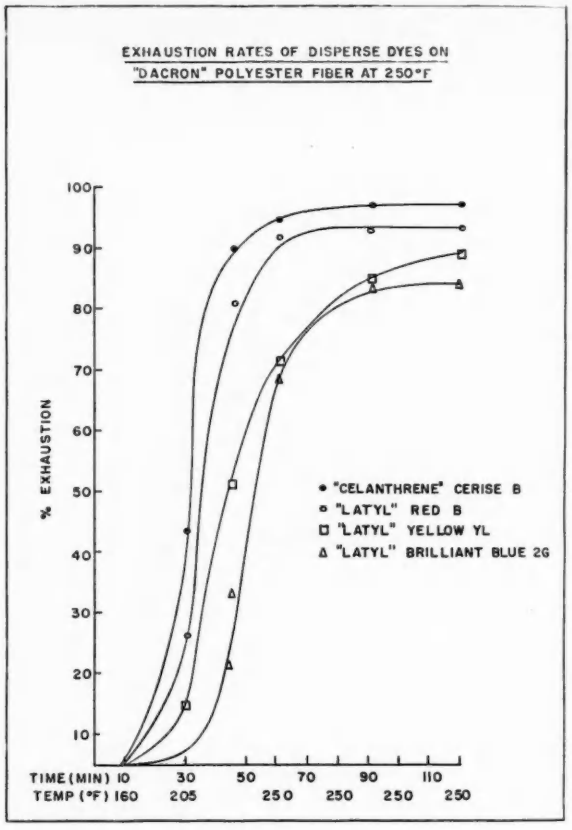

Figure 2
(1.0% dye; no carrier; 20:1 volume)

250°F without a carrier, for dyes of a particular combination that had been observed to yield unlevel dyeings on piece goods.

Previous investigators had noted that the type of agitation employed had a considerable influence on the rate of absorption of dyes by other fibers (*10, 11*). In the present study, the effect of agitation on the rate of dyeing of the disperse dyes by "Dacron" was not investigated. However, the glass tubes were mechanically rotated end over end at constant rpm in the polyethylene glycol bath. Further, excluding the work reported in Table IX, the total volume of liquid in the tubes was always the same regardless of the amount of fiber being dyed.

For carrier dyeing, master dye liquors containing 1.0 g/l dye and 3.0 g/l Dowicide A, adjusted to a pH of 5.3 with acetic acid, were prepared. Forty milliliters of these baths was then introduced into each of several glass dye tubes together with a 2.0-gram skein of staple "Dacron." The tubes were placed in the polyethylene glycol bath and rotated. As the temperature was raised to 205-208°F over 30 minutes and maintained for one and one-half hours, dye tubes were successively removed at regular time intervals, and the skeins were analyzed. Similarly, dyeings were made without a carrier wherein tubes were removed at regular intervals as the temperature was raised to 250°F over one hour and maintained for one hour.

It is apparent from the rate-of-exhaustion data presented graphically in Figures 1 and 2 that "Celanthrene" Cerise B and "Latyl" Red B "strike" appreciably more rapidly than "Latyl" Yellow YL and much more rapidly than "Latyl" Brilliant Blue 2G. Also, the degree of exhaustion of the former two dyes under both conditions of dyeing exceeded that of the latter two dyes.

APPLICATION OF DYE COMBINATIONS——Reith and Andres (*8*) have shown that Celliton Fast Pink RFD-CF and "Latyl" Brilliant Blue 2G exhibited on application in combination at 250°F distributions between bath and fiber like those obtained when applied singly. The question was advanced as to what effect different exhaustion rates might have on such distribution. In other words, would a rapidly exhausting dye tend to "block" a slowly or poorly exhausting dye from the fiber? Therefore, "Latyl" Yellow YL and "Latyl" Brilliant Blue 2G were each applied for two hours at 250°F (20:1 volume) in a series of binary combinations of increasing dye concentration with the relatively rapidly exhausting dyes "Celanthrene" Cerise B and "Latyl" Red B. From the data in Table II it is evident that, regardless of the exhaustion rate of the individual components, each dye exhibits its characteristic distribution between bath and fiber whether applied singly or in combination.

In an extension of this study, several other dyes were examined on dyeing in binary combinations for one hour at 250°F without a carrier. From the data in Table III it is evident that each of these also exhibits its characteristic distribution between bath and fiber whether applied singly or in combination. In fact, no retarding action was evident when the four dyes employed in the binary-combination studies were applied in a series of quaternary combinations. The analytical results are given in Table IV.

EFFECT OF VOLUME RATIO ON EXHAUSTION EFFICIENCY —— In commercial practice new shade formulations are frequently applied initially to a single piece or to a small load. Under

these conditions a long dyeing volume is often necessarily employed. However, when full loads are attempted, shade variations may be encountered. Since it was established in the previous section that such shade differences could not be due to blocking, it was considered desirable to ascertain the effect of volume ratio on the absorption of various dyes.

A) *Carrier Dyeing.* For this purpose a series of dyeings was made on skeins of spun "Dacron" polyester fiber for one and one-half hours at 205-208°F at 20:1 and 60:1 volumes in the presence of various concentrations of Dowicide A with the dyes indicated in Table V at the strengths noted. Each dyebath was acidified to a pH of 5.3 with acetic acid.

Samples of each dyed skein were then dissolved in phenol, and the resulting solutions were evaluated spectrophotometrically.

From the data in Table V it is seen that absorption at 205-208°F from baths containing orthophenylphenol is generally better at 60:1 than at 20:1. This is explained by the fact that there is more carrier present with respect to the fiber at the longer volume. On the other hand, when the ratio of orthophenylphenol to fiber is the same at either volume, e g, 3.0 grams per liter at 60:1 and 9.0 grams per liter at 20:1, exhaustion is somewhat better at the lower volume ratio than at the higher volume ratio. It is noted, however, that "Celanthrene" Cerise B and "Latyl" Violet B, dyes which exhaust fairly well at 205-208°F even without a carrier (Table I), exhibit little difference in dye absorption at 20:1 and at 60:1.

It is also apparent from the data in Table V that some dyes exhaust well with relatively low concentrations of Dowicide A. However, as noted previously, dyeings at 205-208°F without a carrier were poorly penetrated. Hence, surface deposition has occurred with such dyes. Accordingly, low carrier concentrations are likely to yield dyeings of poor fastness to crocking, washing, etc. It is likewise apparent that other dyes exhibit improved exhaustion as the concentration of this carrier is increased. Accordingly, sufficient carrier should be used to insure optimum exhaustion and penetration. Furthermore, consideration should be given to the observations of the Philadelphia Section AATCC, that at a 30:1 volume more than 2.5 g/l of Dowicide A (converted to orthophenylphenol) is required to effect optimum leveling and that at the latter volume more than 7.5 grams per liter of this carrier causes shade changes in some dyes *(12)*.

B) *Pressure Dyeing.* A second series of dyeings was made without a carrier at 20:1 and 60:1 liquor:fiber ratios for one hour at 250°F with 0.5 and 1.0 per cent of the four dyes listed in Table VI.

The absorption data in Table VI show that at 250° F, as was the case in carrier (orthophenylphenol) dyeing when the concentration of carrier was based on the fiber weight, exhaustion of the dyes tested was better at 20:1 than at 60:1.

Mill experience with a ternary combination to produce a gray shade at 250°F substantiates the laboratory evaluations. Socks made from spun "Dacron" polyester fiber dyed for one hour in a rotary pressure dyeing machine yielded a heavier and greener shade of gray at 20:1 volume ratio than at 70:1.

TABLE II

EFFECT OF RAPIDLY EXHAUSTING DYES ON ABSORPTION OF SLOWLY EXHAUSTING DYES

Dye	Initially in bath g/100 g fiber	Grams dye absorbed/100 grams fiber: Applied singly	Applied in combination with "Celanthrene" Cerise B	Applied in combination with "Latyl" Red B
"Latyl" Yellow YL	0.25	0.15	0.15	0.15
	0.50	0.42	0.43	0.42
	1.0	0.88	0.84	0.85
	2.0	1.72	1.69	1.68
"Latyl" Brilliant Blue 2G	0.25	0.11	0.10	0.18
	0.50	0.28	0.32	0.35
	1.0	0.74	0.69	0.79
	2.0	1.54	1.40	1.56

NOTE: Absorptions of the rapidly exhausting "Celanthrene" Cerise B and "Latyl" Red B, respectively, were also essentially the same whether the dyes were applied individually or in the binary combinations. In the above binary dyeings, which were carried out for two hours at 250°F, equal proportions of each component were initially present in the bath.

TABLE III

COMPARATIVE ABSORPTION OF DISPERSE DYES ALONE AND IN BINARY COMBINATIONS TO STAPLE "DACRON" POLYESTER FIBER

Dye	Initially in bath g/100 g fiber	Grams dye absorbed per 100 grams fiber: Applied singly	Applied in combination with: "Celanthrene" Fast Yellow GL Conc 300%	"Latyl" Orange R	"Latyl" Violet 2R	Experimental Disperse Blue
"Celanthrene" Fast Yellow GL Conc 300%	0.125	0.09		0.10	0.11	0.09
	0.25	0.20		0.20	0.21	0.21
	0.50	0.43		0.41	0.43	0.43
	1.0	0.85		0.83	0.90	0.85
	2.0	1.72		1.67	1.73	1.77
"Latyl" Orange R	0.125	0.08	0.09		0.10	0.10
	0.25	0.22	0.23		0.24	0.23
	0.50	0.45	0.47		0.48	0.48
	1.0	0.97	0.98		0.98	0.95
	2.0	1.99	2.0		1.98	2.0
"Latyl" Violet 2R	0.125	0.09	0.10	0.09		0.10
	0.25	0.23	0.20	0.25		0.21
	0.50	0.45	0.45	0.49		0.46
	1.0	0.96	0.95	0.97		0.97
	2.0	1.93	1.92	1.95		1.9
Experimental Disperse Blue	0.125	0.07	0.04	0.07	0.06	
	0.25	0.15	0.13	0.16	0.14	
	0.50	0.29	0.28	0.30	0.30	
	1.0	0.56	0.57	0.58	0.57	
	2.0	0.93	0.97	0.94	0.89	

NOTE: Above dyeings were carried out for one hour at 250°F. Equal proportions of each component were initially present in the baths.

TABLE IV

COMPARATIVE ABSORPTION AT 250°F OF DISPERSE DYES ALONE AND IN QUATERNARY COMBINATION

Applied	Initially in bath g/100 g fiber	"Celanthrene" Fast Yellow GL Conc 300%	"Latyl" Orange R	"Latyl" Violet 2R	Experimental Disperse Blue
Singly	1.0	0.85	0.97	0.96	0.56
Quaternary combination	1.0	0.85	1.00	1.00	0.57
Singly	2.0	1.72	1.99	1.93	0.93
Quaternary combination	2.0	1.70	1.95	1.97	0.96

The analyses that appear in Table VII show improved absorption of the yellow and blue components at the lower volume ratio, and this accounts for the greener shade.

EFFECT OF DYEING TIME ON DYE ABSORPTION AND FIBER PHYSICAL PROPERTIES——In many mill processes it may be necessary to extend the time of dyeing beyond that normally recommended. The question naturally arises as to what effect the extended time of dyeing might have on the absorption of dyes and what effect high concentrations of orthophenylphenol might have on the physical properties of the fiber.

A) *Dye Absorption.* Two series of dyeings were made at 20:1 and 60:1 with 2.0% "Celanthrene" Cerise B and "Latyl" Brilliant Blue 2G, respectively, in the presence of 18.0% Dowicide A (acidified to pH 5.3) based on weight of fiber, i e, 3.0 grams per liter at 60:1 volume and 9.0 grams per liter at 20:1 volume. Dyeing was carried out for 0.5, 1.0, 1.5, 2.0 and 4.0 hours at 205-208°F.

As indicated from the data in Table VIII, the extended dyeing time did not significantly affect the strength of the dyeing obtained. Spectrophotometric curves of the 0.5- and 4.0-hour dyeings dissolved in phenol disclosed no decomposition of either dye.

Although the data in Table VIII indicate that dye absorption in one-half hour is essentially the same as that obtained in four hours, from a practical standpoint it is usually necessary to dye sufficiently long to effect adequate levelness and penetration.

B) *Fiber Properties.* A series of dyeings was made at 10:1, 20:1, 40:1 and 60:1 volume ratios for two hours at 205-208°F in the presence of 3.0 and 6.0 g/l Dowicide A and at 10:1 and 20:1 in the presence of 9.0 g/l Dowicide A. Tensile strength, elongation and denier were determined on the carrier-treated yarn, as well as on the untreated yarn and on yarn treated in water for two hours at 205-208°F. The data reported in Table IX show that, under any of the foregoing conditions, serious degradation of the fiber is not encountered, although the lowest tenacity and greatest denier were observed in the yarn treated in a 20:1 volume of 9.0 g/l Dowicide A.

SUMMARY

In this paper particular attention has been given to factors affecting the absorption of disperse dyes by "Dacron" polyester fiber at 205-208°F from baths in which orthophenylphenol has been employed as a carrier, as well as at 250°F from baths containing no carrier. Particular emphasis was given to those variables with which a practical dyer would be concerned in establishing shades for full-scale dyeing.

Most disperse dyes were observed to have good stability at 250°F and to transfer better, in general, at this temperature than at 205-208°F with orthophenylphenol or benzoic acid as a carrier.

Quantitative data have been presented to demonstrate that dye absorption decreases as the volume is increased either in high-temperature dyeing or in carrier dyeing at the boil, provided, in the latter instance, the ratio of carrier to fiber is

TABLE V

EFFECT OF ORTHOPHENYLPHENOL CONCENTRATION ON ABSORPTION OF DISPERSE DYES AT DIFFERENT VOLUME RATIOS

Grams dye absorbed per 100 g staple "Dacron" polyester fiber

Dowicide A g/l*	"Latyl" Yellow YL		"Celanthrene" Cerise B		"Latyl" Violet B		"Latyl" Blue GE				"Latyl" Brilliant Blue 2G	
	2.0%		2.0%		2.0%		2.0%		5.0%		2.0%	
	20:1	60:1	20:1	60:1	20:1	60:1	20:1	60:1	20:1	60:1	20:1	60:1
0.0	0.59	0.64	1.71	1.58	1.52	1.45	0.53	0.26	0.64	0.61	0.29	0.28
1.0	0.90	1.21	1.99	1.96	1.83	1.85	0.53	0.53	0.91	0.99	0.53	0.65
2.0	1.42	1.95	2.00	1.96	1.88	1.96	0.69	1.01	1.20	1.75	0.73	0.95
3.0	1.83	1.88	2.20	1.97	1.99	1.92	1.01	1.50	1.71	2.96	0.92	1.20
6.0	1.77	1.92	2.06	1.95	2.00	2.06	1.60	1.68	3.63	3.94	1.27	1.67
9.0	1.93	1.88	1.98	2.02	2.06	2.06	1.70	1.65	3.84	3.76	1.58	1.76

* Acidified to pH 5.3.
Dyed for 1½ hours at 205-208°F.

TABLE VI

EFFECT OF VOLUME RATIO ON ABSORPTION OF DISPERSE DYES AT 250°F WITHOUT A CARRIER

Grams dye per 100 grams fiber after one hour

Dye	0.5% dyeing		1.0% dyeing	
	20:1	60:1	20:1	60:1
"Latyl" Yellow YL	0.38	0.23	0.81	0.66
"Celanthrene" Cerise B	0.43	0.37	0.97	0.83
"Latyl" Red B	0.42	0.39	0.93	0.86
"Latyl" Brilliant Blue 2G	0.39	0.31	0.80	0.70

TABLE VII

EFFECT OF VOLUME RATIO ON ABSORPTION OF DISPERSE DYES BY "DACRON" AT 250°F IN MILL DYEINGS

Grams dye per 100 grams fiber

Volume Ratio		"Latyl" Yellow YL	"Latyl" Red B	"Latyl" Brilliant Blue 2G	Total
	initially in bath	0.27	0.14	0.92	1.33
20:1	absorbed	0.19	0.14	0.67	1.00
70:1	absorbed	0.10	0.13	0.42	0.65

TABLE VIII

EFFECT OF TIME ON DYE ABSORPTION WHEN USING ORTHOPHENYLPHENOL AS A CARRIER

Grams dye absorbed per 100 grams fiber

Dyeing time at 205-208°F, hours	2.0% "Celanthrene" Cerise B		2.0% "Latyl" Brilliant Blue 2G	
	20:1	60:1	20:1	60:1
0.5	1.97	1.96	1.50	1.40
1.0	1.92	1.94	1.50	1.44
1.5	1.96	1.94	1.50	1.44
2.0	1.92	1.94	1.50	1.52
4.0	1.94	1.94	1.45	1.50

TABLE IX

EFFECT OF ORTHOPHENYLPHENOL ON PHYSICAL PROPERTIES OF "DACRON" POLYESTER FIBER

Treating conditions 2 hours at 205-208°F				
*Dowicide A** Concn g/l	*Volume Ratio*	*Denier*	*Tenacity g/d*	*Elongation at Break %*
3.0	10:1	625	2.6	44.0
	20:1	669	2.3	43.6
	40:1	672	2.3	46.5
	60:1	708	2.3	47.1
6.0	10:1	724	2.4	45.3
	20:1	618	2.5	45.4
	40:1	720	2.3	48.3
	60:1	651	2.5	48.6
9.0	10:1	688	2.3	46.0
	20:1	780	2.1	47.3
Water	20:1	686	2.3	44.4
Untreated		637	2.4	35.7

* Acidified to pH 5.3.

constant. If the ratio is not constant, i e, if the carrier (orthophenylphenol) is based on the bath liquor, the absorption increases with the volume.

Experiments conducted at 250°F extended and confirmed earlier studies, which indicated that dyes applied in combination exhibit distribution values between bath and fiber similar to those obtained singly, regardless of their rates of absorption.

Time of dyeing as related to dye absorption is less significant when optimum carrier concentration is used than when a minimum quantity is employed.

Exhaustion efficiency of several commercial dyes was observed to be improved at 205-208°F by increasing the orthophenylphenol in the bath. Concentrations of 3.0 to 6.0 grams per liter at a 60:1 volume and 6.0 to 9.0 grams per liter at a 20:1 volume gave optimum dye absorption. At these concentrations the carrier does not exert any serious adverse effect on the physical properties of the fiber.

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1953 Intersectional Contest——

UNION DYEING BLENDS OF WOOL AND SYNTHETIC FIBERS WITH WATER-SOLUBLE AND DISPERSE DYES*

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The practice of blending wool with synthetic fibers is spreading because of the development of new synthetic fibers with unique properties. A special union-dyeing problem exists in cases where the synthetic fiber requires disperse, or acetate, dyes, since the wool present is more or less heavily stained by disperse dyes. This stain generally has poor fastness to light, washing, and crocking.

The purpose of the New York Section Contest Committee was to find means of overcoming the problem, if possible, and thus to increase the applicability of certain wool-synthetic blends by determining principles of union dyeing which give good color fastness.

Specifically including in its scope the three blends, wool-acetate, wool-Dynel and wool-Dacron, this paper reports on the following points:

1) an investigation of the factors that affect the degree of staining of wool by disperse dyes,

2) a study of processes for dyeing wool-acetate, wool-Dynel, and wool-Dacron unions to obtain desirable fastness,

3) the description of several practical applications on a plant scale, of dye selection and of dyeing processes for the blends mentioned. A wide range of colors for socks, suitings, and floor coverings is included.

The conclusion is drawn that union-dyed wool-acetate, wool-Dynel and wool-Dacron fabrics of satisfactory colorfastness can be produced.

I. INTRODUCTION

THE commercial development of many fiber blends will be broadened when the problems of dyeing them in combination are worked out. Fabrics produced from blends which are difficult to union dye have been, for the most part, limited to those that can be made by stock-dyeing the separate fibers and blending them afterward. This method can be commercially applied only to the production of a few colors in large volumes, as for men's suitings, blankets, and plain carpets. The costs of stock-dyeing and blending small orders in many colors are prohibitive for the production of low-price competitive items, such as socks, mittens, sport shirts, and sweaters. The excess costs consist of losses from waste generation in processing stock-dyed material, of labor for segregating and reprocessing the wastes, and of the requirement of keeping in-process inventories in many colors. Furthermore, manufacture starting from white stock takes about two weeks longer than from yarn and four weeks longer than from the piece. This in itself eliminates the use of stock-dyeing in the production of fast-moving types of goods.

Specifically, wool-acetate, wool-Dacron, and wool-Dynel blends are examples of combinations which could be more important commercially but for the dyeing problem. The properties of wool can be extended and/or reinforced by blending with acetate, Dacron, or Dynel, all of which have specific properties of their own to recommend them, and vice versa. The advantageous physical properties of the blends mentioned have already been demonstrated in the production of such items as wool-Dacron and wool-acetate suitings, wool-Dynel kersey, and wool-acetate carpets, for which the respective fibers have been separately stock-dyed.

Acetate, Dacron, and Dynel are most readily colored, when dyed alone, with disperse, or acetate, dyes. Only this class of dyes permits a wide range of shades on acetate, Dacron, and Dynel; it is therefore inevitable that disperse dyes be used on those fibers for most colors, whether the fibers are dyed alone or with some other fiber.

When wool is present in a bath containing disperse dyes, however, it is stained by loosely adhering particles of disperse dye. The stain usually has a smooth, level-dyed appearance but also usually has poor resistance to light, washing, and crocking. Thus, a given color may be formulated with soluble dyes that show excellent fastness on the wool and disperse dyes that show excellent fastness on the synthetic fiber; yet the final union-dyed shade will have poor fastness because the disperse dye stains the wool heavily, and the stain on wool is fugitive.

This staining is the heart of the problem of dyeing wool with fibers that require disperse dyes, and the Committee first addressed itself to the question of whether the problem appeared to be soluble or whether the staining and its fastness are common in degree to all disperse dyes and independent of the dyeing procedure. If the latter should prove to be the case, there would be no freedom in the selection of dyes or dyeing methods and the problem would be insoluble within the framework of current methods for dyeing acetate, Dacron, and Dynel.

The literature was therefore studied first for some indications or leads to the effect that a solution could be found. As will be noted below in much more detail, the literature on dyeing wool in the presence of disperse dyes contains few references, all of which describe the problem of fugitive wool staining but which offer no generalized solution based on the knowledge of underlying principles. Clear indications were found, however, that avenues existed by which a solution could be approached, and the Committee decided to proceed with the investigation.

SCOPE———It is therefore the purpose of this paper to analyze the problems of dyeing wool-acetate, wool-Dynel, and wool-Dacron combinations, with particular reference to the problem of the staining of wool by disperse (acetate) dyes; to determine means of minimizing the staining tendency; to help the practical dyer choose the best dye combinations and dyeing conditions; and, finally, to show the practical application of the techniques described. By way of further establishing

* Presented by E A Leonard at the Conrad Hilton Hotel in Chicago, Ill on Saturday, Sept 19, 1953. Ms submitted by the Editor of Proceedings on June 21, 1954.

the scope of the work, union dyeing is defined as the process of dyeing the component fibers in a blend to the same color. The opposite, namely cross dyeing, means the dyeing of component fibers to different shades. Attention is centered here on union dyeing, rather than cross dyeing, the blends in question because union dyeing is at once the more usual and at the same time the more difficult requirement. The end use will of course determine the dyeing method, and the Committee believes that the techniques of union dyeing can be applied to cross dyeing without special study. The practical objective of this paper, as implied above, is to increase manufacturing flexibility and versatility in processing blends of wool with certain synthetic fibers so as to permit greater realization of the advantages which these blends possess.

II. REVIEW OF LITERATURE

(See Bibliography on page P672)

The literature on dyeing wool with acetate or Dynel or Dacron, while relatively scant, gives several direct leads to the strategy adopted in solving the problem. The earliest record found is no less recent than 1945 and is concerned with methods for union-dyeing wool and acetate. In it Smith *(9)* notes that most disperse dyes stain wool heavily. He recommends a two-step process in which the acetate is dyed first at 140-160°F in the presence of sulfated fatty alcohol and sulfonated oil as dispersing agents, plenty of time being allowed for the acetate to pick up the dye. Then the temperature is raised to 190°F, and neutral-dyeing or level-dyeing acid dyes are added for coloring the wool. If the acetate-dye concentration is high, he states that it is better to start with a fresh bath for the second step.

In 1946 Marius *(5)* notes the wool-staining problem in union-dyeing wool and acetate piece goods for men's and women's clothing. He states that the selection of dyes must be made with care, and that the stain on wool has poor fastness to light. It is claimed that anthraquinone-based disperse dyes should be used, since only they have sufficient fastness, but even within that group careful selection is necessary.

The next reference is in 1947. Clapham & Turner *(3)* state that wool-acetate unions present a difficult fastness problem, and that the particular disperse dyes selected control the staining problem. Only one other small reference *(1)* was noted prior to 1950; it mentions a piece-dyed navy shade on a wool-viscose-acetate cloth, produced by a one-bath process and having good crocking fastness. Further details are lacking.

Mellor and Olpin reported *(6)* in 1950 with considerable detail on union-dyeing wool and acetate. Noting that a good list of wool dyes having no affinity for acetate is available, the paper emphasized the problem of the staining of wool by disperse dyes. The following points were made:

1) The disperse colors that do not stain wool are limited in number, and the stain is almost always fugitive to light;

2) Intensity of wool staining is dependent on a number of factors:

a) pH—stain is least if dyeing is carried out on the alkaline side, but the best compromise for dyeing wool is pH 5 to 7;

b) dyeing time—staining decreases with increased time, other conditions being favorable. The best combination is 90 minutes with a dyebath containing sodium sulfate, ammonium acetate, and a suitable dispersing agent;

c) dye selection — nitroaminoazo types should be avoided since they stain most. A group of the best dyes was listed.

Point 2b above agrees with the recommendation made by Smith *(9)* about dyeing time.

R J Thomas *(11)* reported in August 1952 on improved methods for union-dyeing wool and Dacron, particularly in dark shades. Chrome dyes were used for the wool, and disperse dyes that stain wool least were selected for the Dacron.

The Hellwig Dyeing Corporation reported in 1952 without further elaboration *(4)* that wool and acetate can be satisfactorily union-dyed, wool and Dacron likewise, but that a good union cannot be obtained on wool and Dynel.

The Celanese Corporation has made an extensive study of wool-acetate union dyeing in their Summit, New Jersey, Research Laboratories. The results have not been published, but were reported to this Committee and were outlined in a paper presented by Salvin, Studer, and Ward *(7)*. A summary of the information follows:

1) The problem: disperse dyes have some affinity for wool. The "dyeing" (stain) on the wool is of poor fastness to washing and crocking and is generally of poor lightfastness. One-bath dyeing procedures which result in minimum staining on wool were the objectives of the study.

2) The relative staining of the wool is dependent on the following variables:

a) nature and amount of dispersing agents used with the disperse dyes: for example, sulfated fatty alcohols resulted in heavy wool staining, while certain nonionic dispersing agents showed minimum staining;

b) pH: the dyebath condition affects the dyeing properties of both the wool and acetate fibers and the behavior of the dyes for both fibers;

c) temperature: the relative staining is usually decreased with increased temperature. This point cannot be applied without considering other factors, however, such as the tendency of acetate to deluster if dyed at too high a temperature, such as 212°F;

d) dyeing time: relative staining of wool decreases with increased dyeing time. Disperse dyes "strike" on the wool at the start of dyeing, but, as dyeing proceeds, the partition favors the acetate;

e) dye concentration: staining is roughly proportional to the dyebath concentration, but is relatively heavier at low concentration.

3) Stains produced on wool by different disperse dyes vary considerably in fastness.

a) Stains of azo reds are all poor to light, while anthraquinone-red stains are of moderate light fastness. Anthraquinone-blue stains have moderate light fastness, while yellow stains have wide individual variations.

b) Disperse-dye staining on wool generally has poor wash fastness. This fact may be used to advantage in the development of a clearing process to remove loosely held disperse dye from the wool at the end of the dyeing cycle.

4) It was concluded from this laboratory study that it may be possible to improve the process for acetate-wool union dyeing by the proper choice of dispersing agent, dyes, and dyebath conditions.

In the Spring of 1953 Sandoz Chemical Works published a booklet *(8)* on the dyeing of blends, which includes recommendations for dyeing wool-Dacron and wool-Dynel combinations. On wool-Dacron blends they advise that it is possible to union dye in a one-bath process or to cross dye either fiber. Disperse dyes should be selected for least staining on wool; acid or chrome dyes may be used for the wool. A slightly acid pH is recommended, with a swelling agent for the Dacron, and the dyeing should be carried out at the boil.

Wool-Dynel unions are stated to be possible, but shade control is difficult because of the wool-staining tendency of disperse dyes. The procedure is almost the same as for wool-Dacron, with the addition of a soaping off after dyeing to reduce the stain.

Szlosberg very recently discussed *(10)* the dyeing of blends and touched upon wool-Dacron combinations. He stated that even careful selection of disperse dyes cannot prevent wool staining to some degree and advised a soaping off after dyeing to wash down the stain. He also mentioned that a resisting agent to keep disperse dye off the wool should be sought.

This completes the group of references found, and the material above therefore summarizes the information on which the Committee could draw conclusions and plan work. Certainly the problem of the staining of wool by disperse dyes has been well recognized, but it is also clear that a certain amount of freedom exists in the selection of dyes and dyeing procedures to modify the staining effect, at

least to a limited degree. This fact indicates the existence of underlying principles which, if understood, could be used to formulate a general and satisfactory method for dyeing all three of the blends in question. To get a clearer picture of the material in the literature the following summary points can be listed, with such interpretation as deemed advisable added parenthetically:

1) of the 10 references found, six (*1, 3, 5, 6, 7, 9*) deal with wool-acetate blends exclusively, two (*10, 11*) consider wool-Dacron alone, one (*8*) discusses wool-Dacron and wool-Dynel blends and one (*4*) mentions all three types. Most of the detailed data concern wool-acetate blends, a few are available on wool-Dacron, but there is very little information indeed on wool-Dynel blends, and that is not optimistic. (The unbalance of information was considered to be not so bad as it might seem, since the principles which govern wool staining found in the references on wool-acetate blends should be equally applicable to the other two types.)

2) the means for obtaining at least partial success in dyeing wool-acetate unions appears to be available, with a need for relatively little further investigational work before making trial applications. (Wool-acetate blends were therefore approached first in the investigations reported below.)

3) several factors that affect the extent of wool staining by dispersed dyes are indicated:

a) dye selection——anthraquinone types are alleged to be better than azo types;

b) pH——slightly acid pH levels seem to be favored;

c) dyeing time——short cyles are disfavored, on the principle that increased time favors the exhaustion of disperse dyes on the synthetic fiber, leaving less available to stain the wool;

d) the nature of the dispersing agent used for the disperse dyes. Specific recommendations are not in agreement.

It was agreed that experimental work was first needed to check in detail some of the general recommendations in the literature (such as the one which, appearing three times *(5, 6, 7)*, states that anthraquinone-base disperse dyes have staining and stain-fastness properties superior to those of azo-base disperse dyes), to reconcile contradictory reports (such as Smith's *(9)*, which recommends a dispersing agent that Salvin, Studer, and thraquinone-base disperse dyes have staining), and to test hypotheses developed from the literature and subsequent work. The next section describes these investigations.

III. EXPERIMENTAL

A series of laboratory experiments, each designed to test an hypothesis or check a statement in the literature, was performed. These tests will now be described.

EXPERIMENT A

Wool Staining as a Function of Dye Type and Dyebath Conditions

Purposes

(1) To get a detailed picture of the wool-staining properties of representative disperse dyes, both individually and by groups according to chemical structure;

(2) To determine in detail how dyebath conditions affect the degree of wool staining;

(3) To determine crock fastness and wash fastness of wool stains (light fastness to be done in later work reported below).

Procedure

(1) Samples of forty different commonly used disperse dyes were contributed by manufacturers, and equivalent strengths were determined by making dyeings on acetate. The dyes[1], strengths, and notes on structure where available are listed in Appendix A.

[1] It was originally intended that, in this paper, dyes be identified by Colour Index or Prototype numbers or by structure, rather than by trade name. This proved impractical, however, since almost half the dyes in this group have no numerical identification and the structures of many are not revealed. Trade names are therefore used, and Prototype and Colour Index numbers are also given if available.

(2) These disperse dyes were "dyed" on wool yarn alone according to seven methods, ranging from neutral to strongly acid and including metachrome and topchrome. Dyeings were made at equivalent strengths as noted in App A. The dyeing methods are detailed in App A II. No dispersing agent was added to the dyes in making up the dyebaths.

(3) The "dyeings", or stainings, were noted for comparative depth and shade and then tested for fastness to No. 2 Wash Test and crocking before and after washing.

Results

(1) *On depth of staining, differences among dyes:* With the exceptions of a very few dyes that showed very strong staining tendencies, the greatest number showed moderate and approximately equal degrees of staining. Those which showed the heaviest staining were the following listed in Appendix A I according to the indicated numbers:

9	Cibacete Rubine 3BS, Pr 239, azo type
11	Celliton F Brown 5RA-CF, Pr 231, azo type
15	Amacel Red 2B, azo type
20	Celliton F Yellow 4RL Conc, probably azo
38	Artisil Direct Blue GFL

(2) *On the effect of dyebath conditions over the degree of wool staining:* Details are noted in App A IV. The details may be summarized by stating that the behavior of the different dyes in response to varying acidity showed three distinct cases as follows:

Case	*Description*	*Number of Dyes*
A	Neutral-dyeing procedures showed the lightest staining, and least wash fastness.	6
B	Staining is greatest with the neutral-dyeing procedures, while increasing acidity of the bath resulted in successively weaker staining.	8
C	In most cases, all dyebath conditions showed about the same degree of staining.	26
		40

In addition, a few of the dyes underwent radical shade changes in the chrome procedures because of chromation of some kind. These shade changes were accompanied particularly by increased fastness to washing and by some improvement in crocking fastness.

(3) *On crocking and washing fastness of stains:* In accordance with the bulk of the literature references, the wash fastness of the stains was almost universally poor for all dyes and all dyeing methods, except for the few cases noted where gross shade changes occurred in chromation. Crocking fastness, on the other hand, was by no means universally poor; it averaged fair to good on the yarns as dyed, and good to excellent after washing. (The strength "dyed" resulted in medium-weight shades on the yarns.)

Interpretations

(1) In the absence of dispersing agents other than what is in the dyes as manufactured, there would appear to be relatively small differences among dyes as to inherent staining properties, except as noted. Bearing in mind that synthetic fiber was not present in this test and the effects of exhaustion on synthetic fiber were eliminated, these findings do not bear out References *(6)* and *(7)*, which note wide individual variations in staining tendencies and generalizations by chemical structure, but of whose test methods we have no knowledge. Let us hypothesize in a simple way, however, what might have happened, by considering two disperse dyes, *A* and *B*. *A* has a 75% exhaustion on acetate, while *B* has a 60% exhaustion, and equal weights on acetate give equal color depth. Thus we must make a dyebath containing 4 grams of *A* to get 3 grams on acetate, and a bath containing 5 grams of *B* to get 3 grams on acetate. If wool and acetate are present *together* in each of these baths, the wool can pick up what is not exhausted on the acetate, and the weight ratios on the wool of dyes *A* and *B* will be 1 to 2, or a considerable apparent difference in staining. On the other hand, if wool alone is put into the baths, then the ratios of dyes *A* and *B* picked up will be 4 to 5, a negligible apparent difference in staining tendency. We may conclude, then, that comparative staining tendencies are a function of how they are measured, and that the extent of exhaustion on the synthetic fiber and the net remaining amount in the dyebath

are important factors in the apparent "staining tendency of the dye". This is borne out strongly in Part V and Appendix B, where staining tendencies *in the presence of acetate* are noted, and vary much more individually than in this experiment.

(2) Were it not for Case B dyes in respect to dyebath conditions, the results would bear out the recommendations in the literature favoring neutral conditions as a practical method for handling the wool dyeing as well as for minimizing the disperse-dye staining. It was suggested that Case B behavior resulted from flocculation and precipitation of the disperse dye in the presence of acid, and Experiment B, below, deals with this case.

(3) It seemed at first glance that chromation of disperse dyes to increase their wash fastness on wool might be promising, but the shade change of the dyes was so great, the dyes which showed this behavior so few, and their color range so limited that it was concluded to be an approach with no practical significance.

(4) The improvement of crocking fastness and ease of wash down for most of the stains suggest that a clearing procedure at the end of the union dyeing cycle may improve the fastness of the finished color. This is used in some of the applications reported below.

EXPERIMENT B

Effect of Dyebath Acidity on Aggregation of Dispersed Dyes

Purpose

To test the hypothesis that the Case B performance is due to aggregation of the dye in the presence of acid.

Procedure

Three dyes were chosen as examples of Class A, B, and C, respectively, from the results of Experiment A and were examined in more detail as to their properties in solution. Without the making of actual dyeings, these three dyes were made up to dyebaths of varying acidity and were examined at once, after 2 hours' heating, and then after standing 24 more hours for signs of change in degree of dispersion, such as flocculation, tarring, etc.

The dyes tested were

Case A———Amacel Violet FSI
Case B———Cibacete Red YNB Ext Conc
Case C———Amacel Blue GLF

Results

See Table I. It is clear that the Case B dye particles aggregated in the presence of strong acid, and that the aggregation was further promoted by heating the dyebath. This performance is known to promote surface deposition of dye on fiber rather than penetration, which produces a thin and weak shade in contrast to a well-penetrated dyeing.

TABLE I

THE EFFECT OF DYEBATH ACIDITY ON DISPERSION OF ACETATE DYES

Dye Type & Behavior	*Dyebath Composition*	*Visual Estimate of Dye Dispersion in Dyebath*		
		Fresh Dyebath	*After 2 hrs 180°-190°F*	*After standing 24 hrs at room temp*
Case A Amacel Violet FSI	1) Neutral A 2) Neutral B 3) 2% acetic 4) 3% sulfuric 5) 6% sulfuric	sli cloudy, all the same	deeper in color than fresh dyebaths, all still the same	no change
Case B Prototype 236	1) Neutral A 2) Neutral B 3) 2% acetic 4) 3% sulfuric 5) 6% sulfuric	dull & cloudy dull & cloudy brighter, clearer returns to cloudy returns to cloudy	flocculates flocculates flocculates flocculates & tars flocculates & tars	no change no change no change large dark aggregate: form large dark aggregate: form
Case C Amacel Blue GLF	1) Neutral A 2) Neutral B 3) 2% acetic 4) 3% sulfuric 5) 6% sulfuric	almost clear almost clear almost clear sli dull dull	deeper color deeper color deeper color flocculates flocculates sli	flocculates sli flocculates sli flocculates sli aggregates sli aggregates sli

Interpretation

(1) It can thus be concluded that some disperse dyes are adversely affected by the presence of acid in the dyebath. This explains the behavior of the Case B dyes. Most disperse dyes are not affected by the presence of acid and show no differences in staining tendency whether dyed in the presence of acid or neutral.

(2) It can also be concluded, therefore, that neutral to strong-acid union-dyeing procedures that include the use of disperse dyes may be used for blends of wool and synthetic fibers, provided Class B dyes, which are few in number, are avoided. By the same token, chrome-dyeing procedures may be used for the wool portion of the blend if those few disperse dyes that show radical shade changes are omitted.

EXPERIMENT C

The Effect of Dispersing Agents on Wool Staining

Introduction

In Experiment A, six disperse dyes showed a type of behavior called Case A, wherein the wool stain was lightest with a neutral dyebath, getting somewhat heavier with successively lowered pH. There were no signs of differences in degree of dispersion as a function of acidity. An hypothesis may be formulated, however, to the effect that the wool-dye system is subject to the laws governing surface-active materials, in the same way as wool and acid dyes are affected by the acidity of the dyebath. In other words, some acetate dyes may show an affinity for the fiber which is determined in part by the electrical potential of the fiber. It is known that the positive charge of wool fiber increases with acidity.

This leads us to a consideration of the effects which surface-active materials may have on the system, specifically the dispersing agents used with the acetate dyes. This experiment was made to illustrate the effect of dispersing agents on staining tendencies.

Purpose

To determine the extent to which the nature and amount of dispersing agent affects the degree of disperse-dye staining on wool.

Procedure

(1) Union dyeings of wool and acetate cloths were made with equal weights of the two materials at a 50/1 water/fiber ratio.

(2) With 2% of dye on weight of acetate, three dyes were tested with each of three concentrations of three different dispersing agents. The dyeings were carried out at 185° F for 1 hour.

(3) After dyeing, the weight of shade on both wool and acetate cloths were individually estimated by visual comparison with sets of cloths dyed in steps of known concentrations of the same dyes used in the test.

(4) For each test dyeing, the depth estimated on the wool was divided by the depth estimated on the acetate to obtain a ratio of the weight of shade on wool to acetate. For example, a wool cloth is estimated at 0.3%, and the acetate at 1.5%; the ratio is $0.3/1.5 = 0.2$. The lower the ratio, the less the staining, and vice versa.

Results

(1) The ratios of weight on wool to weight on acetate are shown in Table II. It is clear that the nonionic dispersing agent favored low staining.

(2) It was noted that care need be taken in estimating wool stain as a relation to depth of shade on acetate rather than on the basis of its own depth alone, because the dispersing agents usually affect the exhaustion on synthetic fiber as well as the stain on wool. For example, a dispersing agent which cuts wool stain in half has no real advantage if it also

TABLE II

STAINING RATIOS FOR DISPERSE DYES—COLOR ON WOOL TO COLOR ON ACETATE

Dispersing Agent Concn, g/l Type	1	2	3
	Ratios for Amacel Yellow CW		
Anionic #1 (sulfonated castor oil)	0.2	0.25	0.32
Anionic #2 (sulfated fatty alcohol)	0.15	0.15	0.22
Nonionic (polyethylene oxide ester)	0.091	0.089	0.088
	Ratios for Amacel Red FSI		
Anionic #1	0.19	0.28	0.35
Anionic #2	0.19	0.22	0.27
Nonionic	0.13	0.13	0.13
	Ratios for Celliton Blue Green BA		
Anionic #1	0.16	0.18	0.22
Anionic #2	0.13	0.17	0.21
Nonionic	0.14	0.14	0.13

halves the exhaustion of dye on the synthetic fiber. The *partition* of dye between wool and acetate rather than the absolute amount on the wool is the important factor. In this experiment, the type of dispersing agent was more important than the amount, but increasing amounts of all three types tended to reduce the exhaustion on the acetate.

(3) Increasing amounts of the two anionic agents increased the absolute amount of staining on the wool, while increasing the amount of the nonionic agent decreased the absolute staining on the wool. Excessive detergent reduces the exhaustion of dye on the wool.

Interpretation

The findings of this experiment agree with those of Salvin et al *(7)*, who recommend nonionic dispersing agents for minimum staining. Their paper reinforces the data recorded here by citing several other dispersing agents, and all the anionics cause more staining than the nonionics.

The precise mechanism of stain promotion by anionic agents was not determined, but it is quite clear from the literature on substantivity that anionic agents will exhaust on wool, the more so the stronger the acidity of the bath.

Weatherburn et al *(12)* have shown that wool is the most substantive of all fibers towards soap, a strongly anionic agent, and they list references to several other articles on the subject. So there is no doubt that anionic dispersing agents, being surface-active, are substantive to wool, and, occluding on the surface of dispersed dye particles as they must to stabilize the dispersion, promote the exhaustion of the dye particles onto the surface of the wool. It can further be rationalized that the insoluble dye particles are too large to penetrate inside the wool fiber and are therefore somewhat loose to crocking and washing.

An experiment was made varying the amount of wool with constant weight of acetate. The degree of wool staining did not change materially and reinforced the belief that wool staining is a surface adsorption effect, rather than true dyeing. A true dyeing would follow the partition laws characteristic of acetate.

EXPERIMENT D

The Effects of Dyeing Time and Temperature on Wool Staining

Introduction

Statements made by Smith *(9)* and by Salvin et al *(7)* indicate that the degree of wool staining reduces as the dyeing time of wool and acetate blends is increased. Also, in the course of making dyeings for the work already described, it was observed that the staining of wool in making acetate-wool dyeings was greater at the beginning of the dyeing than at the end, and the effect of dyeing time was therefore considered worthy of investigation. By the same token, temperature was considered important enough to warrant a couple of parallel experiments.

Purpose

To determine the effects of dyeing time and temperature on the extent of wool staining by dispersed dyes.

Procedure

(1) Equal weights of wool cloth and acetate cloth were dyed together at a 50/1 water/fiber ratio with each of three disperse dyes at 2% owf. No dispersing agent was used other than what was in the dyes as received.

(2) Dyeings were run for one hour at 167°F and 194°F, with equal-sized specimens of both types of cloth taken out after 10 minues, after 30 minutes, and at the end of the dyeing.

(3) The partition ratio of dye on wool to dye on acetate was then determined for each pair of specimens as described in Experiment C.

Results

(1) Table III gives the ratio of dye on wool to dye on acetate as dyeings proceeded at each of two temperaures. It is clear that relative staining on wool reduces with longer dyeing time, and this confirms the work of Smith and Salvin.

(2) Higher dyeing temperature resulted in less wool staining with Amacel Red FSI and Eastman Blue GLF, but the opposite is the case with Amacel Yellow GLF. This can be explained by the facts that most disperse dyes exhaust better on acetate the higher the temperature, but that two, of which Amacel Yellow GLF is one, have "reverse temperature coefficients", or exhaust better at lower temperatures. The other is Eastman Fast Yellow 4RLF.

Interpretation

It appears that the extent of wool staining is related to the amount of acetate dye in the dyebath at any given time. At the beginning of dyeing, the disperse dye concentration is greatest, and this causes the initial heavy staining. As dyeing proceeds, part of the dye is absorbed on the acetate, and this leaves less available in the bath to stain the wool. Greater exhaustion of disperse dye on acetate is produced usually at higher temperatures, and higher temperatures also favor the removal of dye from the solution and tend to reduce staining on the wool.

Caution is necessary in the matter of higher temperatures, however, since dyeing above 194°F (90°C) tends to deluster acetate and Dynel, and since dyes which have reverse temperature coefficients will stain wool more at higher temperatures. As noted above, only two common cases exist.

EXPERIMENT E

The Effect of Residual Oil Content on Degree of Wool Staining

Introduction

A suggestion was made that, since disperse dyes are oil-soluble, residual oil content on wool would promote staining in the dyebath by virtue of the disperse dye dissolving in the oil film on the wool fiber. It was decided to investigate.

Purpose

To test the hypothesis that the presence of residual oil on wool increases staining tendency because of the oil solubility of disperse dyes.

Procedure

(1) White wool yarn was drycleaned to remove all oil possible.

(2) The clean yarn was treated with toluene solutions of a self-emulsifying mineral-base spinning oil so as to give graded residual oil pickups after centrifugal extraction to make the application uni-

TABLE III

EFFECT OF DYEING TIME AND TEMPERATURE ON PARTITION OF DISPERSE DYE BETWEEN WOOL AND ACETATE

Dyeing Time mins	Amacel Red FSI 167°F	Amacel Red FSI 194°F	Amacel Yellow GLF 167°F	Amacel Yellow GLF 194°F	Eastman Blue GLF 167°F	Eastman Blue GLF 194°F
	Ratios of Color on Wool to Color on Acetate					
10	0.35	0.28	0.80	0.58	0.80	0.50
30	0.21	0.17	0.38	0.43	0.30	0.28
60	0.15	0.12	0.20	0.38	0.25	0.20

form. The applied amounts of oil were 0.13, 0.70, 1.2 and 1.8% owf.

(3) The treated and dried yarns were "dyed" at 50/1 water/fiber ratio for 1 hour at 185°F with 0.5% owf of three dyes:

(a) Pr 244 (Artisil Direct Scarlet GP)

(b) Pr 242 (Artisil Direct Yellow G)

(c) Pr 228 (Artisil Direct Blue BSQ)

The dyeing assistants used were 10% Glauber's salt and 5% ammonium sulfate. No dispersing agent was added.

(4) After "dyeing", half of each skein was scoured in a solution of nonionic detergent with 0.38% soda ash at 120°F for 3 minutes.

(5) All skeins were then measured for color on a GE recording spectrophotometer to determine the relative concentrations of dye present, a value of 100 being assigned to the "dyed" unscoured color on the skein with least oil. In effect, then, the depth of shade on all other skeins stained with the same dye is expressed as a percentage of the shade of the unscoured skein with least residual oil.

Results

(1) Figures 1, 2, and 3 show the plotted data. On all three dyes, staining increased with residual oil content on the wool. The average difference in staining between wool of about 0.1% and 1% residual is about 10%.

(2) In two out of three cases, scouring after dyeing almost neutralized the effect of the higher residual oil.

(3) In all cases, scouring after dyeing reduced the staining below the unscoured level of stain on the cleanest wool.

Interpretation

It can be concluded that thorough scouring of blended yarn or piece goods before dyeing so as to remove as much residual spinning oil and grease as possible is conducive to the reduction of wool staining by disperse dye.

The probable value of a clearing process after dyeing is again illustrated in the reduction of stain by a postdyeing scour. Even though this process appears to overcome the effect of heavier initial staining where considerable residual oil is present, thorough prescouring would still be desirable to minimize the shade change in clearing and to make shade control easier.

This concludes the laboratory experimental work concerned with the principles that affect the degree of wool staining by disperse dyes. These principles were next used to develop generalized dyeing procedures for wool-acetate, wool-Dacron, and wool-Dynel blends.

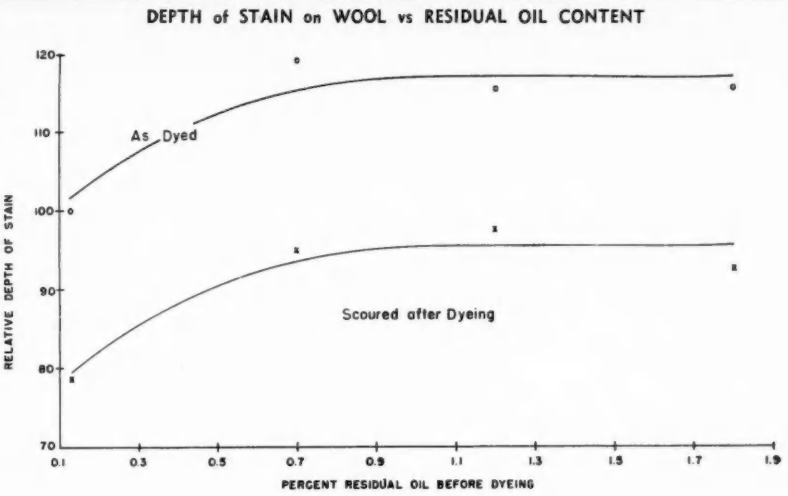
DEPTH of STAIN on WOOL vs RESIDUAL OIL CONTENT
As Dyed
Scoured after Dyeing
RELATIVE DEPTH OF STAIN
PERCENT RESIDUAL OIL BEFORE DYEING

Figure 1
0.5% Artisil Direct Scarlet GP

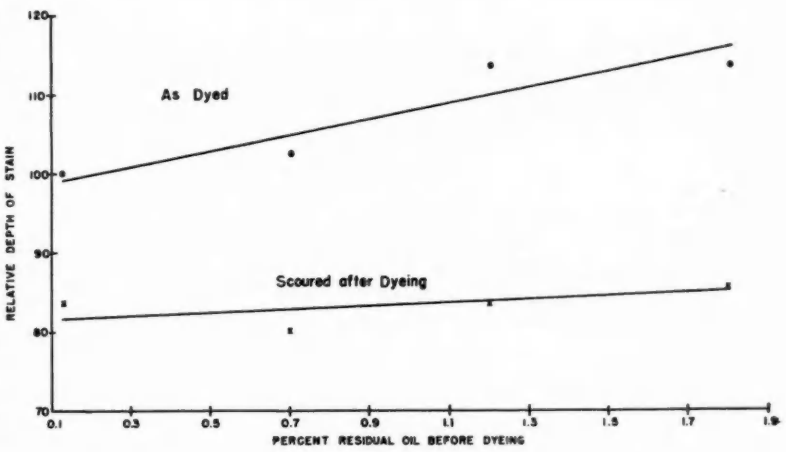

Figure 2
0.5% Artisil Direct Yellow G

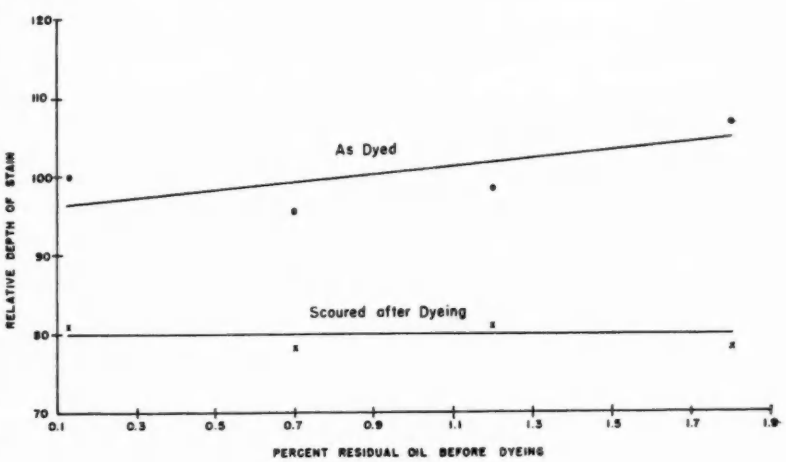

Figure 3
0.5% Artisil Direct Blue BSQ on Wool

IV. SELECTION OF DYEBATH CONDITIONS AND DYEING PROCEDURES

Based on the experiments above and the direct experience of those participating in the Committee work, the following conditions and procedures were screened out as being probably the best combination of circumstances. The dyeing methods described here were considered as generalized recommendations for good practice, and the exact procedures used for the practical applications reported farther on were based upon these general methods as a starting point. While it was found necessary to make a few changes for certain specific applications, the general procedures were remarkably sound throughout.

(A) WOOL-ACETATE UNION DYEING

(1) prescour the material to obtain minimum residual extractable content.

(2) prepare a neutral or slightly acid bath with 5% ammonium acetate owf.

(3) paste the disperse dyes in warm water (do not boil) with a nonionic and/or selected low-staining anionic dispersing agent; ¼ to ½% dispersing agent on weight of fiber (owf) is good practice.

(4) dissolve wool dyes separately by boiling. A selection of neutral-dyeing acid colors is best used for the wool portion of the blend.

(5) dye the material at 180° to 190°F for not less than one hour before sampling to get maximum exhaustion.

(6) in matching shades, the color should be brought close on acetate with the initial disperse-dye weighup, and the final match should be made with additions of only wool dye.

(7) for heavy shades, a clearing at the end of dyeing is desirable. Fifteen minutes in a fresh bath at 110°F with ¼% detergent is suitable.

(B) WOOL-DACRON UNION DYEING

(1) prescour the material to get the best possible cleanliness in terms of low extractables.

(2) prepare the dyebath with a suitable carrier, as determined by preference and compatibility with the pH required for the wool dyes.

(3) paste the disperse dyes in warm water with a nonionic and/or low-staining anionic dispersing agent, which should have some emulsifying properties to assist leveling.

(4) dissolve the wool dyes, which may be neutral-dyeing acid, level-dyeing acid, or chrome colors, by boiling up separately.

(5) enter the material and add the dispersed dyes, with acid if required by the carrier. Add the wool dyes next, or later if preferred.

(6) run 1½ hours at the highest temperature obtainable (208 to 212°F) before sampling.

(7) in shade matching, bring the Dacron close with the initial disperse-dye weighup, and shade with wool dyes only to make the final match.

(8) rinse and scour to remove the carrier. This step will also satisfactorily clear the wool of disperse-dye stain.

(C) WOOL-DYNEL UNION DYEING

(1) prescour the material to obtain minimum extractable content; material that has already been carbonized and fulled, however, needs only to be rinsed until neutral. Carbide and Carbon *(2)* and Zimmerman *(13)* have discussed scouring methods suitable for wool-Dynel blends.

(2) prepare the dyebath at 100°F with such salt and acid as required by the wool dyes, and enter the material.

(3) paste the disperse dyes in warm water with either a nonionic or low-staining anionic dispersing agent, or without a dispersing agent. In the latter case strain the dispersion before adding it to the dyeing machine.

(4) separately dissolve the wool dyes, which may be metallized, level-dyeing acid, or neutral-dyeing acid colors.

(5) add all dyes to the dye machine, raise the temperature slowly to 170°F, and hold there for 20 minutes. Then raise the temperature slowly to 210°F and run 1 hour before sampling for color.

(6) in shade matching the Dynel should be brought close on the initial dye weighup. Final matching is made with wool colors, although small amounts of dispersed dye may be added, since a post-dyeing scour is desirable.

(7) after dyeing, scour with a nonionic detergent, sequestering agent, and a little alkali if necessary to neutralize acid. A suitable scouring condition is 160°F for 30 minutes. Rinse and acidify slightly.

V. DYE SELECTION

This section is intended for the dyer's aid in choosing the disperse dye type for a given application in dyeing blends of wool-acetate, wool-Dynel, and wool-Dacron. Tables of data described below were prepared from the results of union-dyeing tests on the three blends in question. These tables do not constitute recommendations of dyes which should or should not be used; they state the staining and stain fastness of the disperse dyes on the blends involved. The Committee recognizes that dye selection will be governed by the end-product fastness requirements and dyeing costs for specific instances. The data are therefore presented in full for the dyer's interpretation in making selections.

In Experiment A and Appendix A forty well-known disperse-dye types were evaluated for staining tendencies on wool under various dyeing conditions. It was noted that the staining tendency is very likely affected by the presence of synthetic fiber and should also be considered in the light of other conditions necessary for dyeing fibers in combination.

All forty dispersed dyes were therefore retested on wool-acetate, wool-Dynel, and wool-Dacron blends under the dyeing conditions found suitable from Experiments B through E and from the experience of the Committee members, which were assembled into the procedures detailed in the last section of best methods.

A few other dyes were added to the study where it was known that they could make a contribution to the problem at hand.

(A) DISPERSE DYES ON WOOL-ACETATE BLEND———The data are tabulated in Appendix B. The variety of staining depths among the dyes is considerably greater than that found in Experiment A, indicating the influence of acetate fiber in the bath. Depth of stain still does not relate to dye chemical structure in any consistent way, however, and it is recommended that selection be made on the basis of individual test results rather than chemical structure. In other respects, the tables are self-explanatory.

(B) DISPERSE DYES ON WOOL-DYNEL BLENDS———Appendix C contains the compiled data. In this case a first screening of 44 dyes was performed with acid- and chrome-dyeing procedures. Table I lists the test results, and App C describes the dyeing procedures.

Then the dyeings which showed promise of best light fastness on Dynel were exposed for longer periods and were also examined for wash fastness and resistance to perspiration. These results are noted in App C; the methods are given in the literature reviews.

(C) DISPERSE DYES ON WOOL-DACRON BLENDS———Appendix D is a tabulation of the test results made from the evaluation of 46 dyes. In this case six high-temperature disperse dyes of the "Latyl" group developed for Dacron were included. The dyes were tested in both acid and chrome processes, which are also described.

Those dyes that showed poorest light fastness on Dacron were not evaluated for depth or for light fastness of wool stain.

VI. PRACTICAL APPLICATIONS

It was considered necessary to test the value of the findings so far reported for their adaptability to plant-scale operations before it would be finally concluded that the problem of dyeing wool in combination with fibers colored by disperse dyes was solved. A group of test applications was accordingly decided upon, made, and is reported in this section. The applications were as follows:

(1) piece-dyed wool-acetate suiting cloth,
(2) package-dyed wool-acetate carpet yarn,
(3) piece-dyed wool-Dynel suiting cloth,
(4) package-dyed wool-Dynel hosiery knitting yarn, and
(5) piece-dyed wool-Dacron suiting cloth.

All the applications were brought to the finished end-product state, and fastness was tested. The applications and test data will now be described.

(A) PIECE-DYED WOOL-ACETATE SUITING ——— Suiting cloth made of 50% wool and 50% acetate was union-dyed to two shades as detailed in Table IV. The finished cloths were tested for resistance to light, wet and dry crocking, washing, perspiration, dry cleaning, and gas fading. The shades dyed were a light blue and a tan, and the finished cloths were fabricated into men's slacks. The material has satisfactory color fastness for men's suiting.

For this application, the general procedure of union-dyeing wool and acetate was used almost without modification of any kind; neutral-dyeing acid colors were used for the wool, the disperse colors were selected for light fastness, gas-fading resistance, and low wool staining. The latter was further controlled by choice of dispersing agents (Quaker Ester 236 is nonionic and Tamol N is a low-staining anionic of high dispersing qualities) by use of full dyeing time before color sampling and by final matching with wool dyes only.

(B) PACKAGE-DYED WOOL-ACETATE CARPET YARN———A 19-color carpet (18 dyed shades plus white) was reproduced with yarns consisting of 50% wool and 50% acetate (Celcos type). All yarns were package-dyed according to union-dyeing formulas like the typical examples in Table V. Applicable fastness tests were also made. All shades have entirely satisfactory color fastness for this end use. The slight color bleeding in hot water observed on two of the colors is not out of line with the wet-fastness requirements of floor coverings. This application supports the one above by showing suitable properties for a wider range of shades. Also, as above, neutral-dyeing acid colors were used for the wool, and the dispersing agents were the same. The yarns were prescoured with ¼% polyethylene oxide nonionic detergent owf in the package dye kettle and rinsed. A fresh bath was prepared at 110°F with dyes and assistants, and the temperature was raised to 180°F in 30 minutes. The yarns were rinsed but not cleared after dyeing. Other details are noted in Table V.

It is concluded from the above application tests that the union dyeing of wool-acetate blends is a pactical process, which can be applied to a wide range of shades without difficulty by following the principles recorded in earlier sections of this paper.

(C) PIECE-DYED WOOL-DYNEL SUITING———A tan shade and a dark-brown shade were union-dyed on winter-weight suiting piece goods made of 70% wool and 30% Dynel. Table VI shows the dye formulas. The fastness properties are adequate for the purpose intended. In this case, ladies' suiting was fabricated from the cloth and is showing good service.

In making the dyeings, a few modifications of the general procedure previously given were made:

(1) A cationic assistant was found to improve leveling of the wool dyes.

(2) Slow addition of salt at the boil was substituted for putting it in the bath at the beginning. This permitted elimination of the intermediate step of holding the temperature at 170°F for 20 minutes, and it shortened the over-all procedure by about ½ hour.

(3) The finishing processes to be used on the cloth were considered in shade matching, as noted immediately below.

Inasmuch as relustering of the Dynel is effected during decating of the fabric, sample patches taken for shade matching were subjected to conditions that simulate decating.

Dynel-wool blend fabric may be han-

TABLE IV

SPECIFIC PROCEDURE FOR DYEING WOOL-ACETATE BLENDS

Item	*Light-Blue Shade*	*Tan Shade*
Material	50-50 wool-acetate	50-50 wool-acetate
Assistants		
Tamol N	0.5 g/liter	0.5 g/liter
Quaker Ester 236	0.5 g/liter	0.5 g/liter
Ammonium acetate	5% owf	5% owf
Glauber's salt	10% owf	10% owf
Bath ratio	40/1	40/1
Dyes	*% owf*	*% owf*
Eastone Red GLF	0.02	0.05
Interchem Acetate Yellow HDLF-40	0.07	0.21
Eastman Blue GLF	0.40	0.15
Azo Rubinol 3GP	0.10	0.13
Xylene Milling Yellow P	0.10	0.18
Anthraquinone Blue SKY	0.11	0.15

Dyeing Procedure

1) Prepare dyebath at 80° F with Tamol, Quaker Ester and ammonium acetate.
2) Add dyes and raise to 180° F in 30 minutes; add Glauber's salt.
3) Dye 1 hour at 180°F. Use acid dyes for final matching.
4) Cool and rinse with warm water.
5) Scour lightly at 100° F for 15 minutes with 1 g/l Tamol N and follow with a rinse.

TABLE V

TYPICAL FORMULAS FROM 18 CARPET COLORS UNION-DYED ON WOOL-ACETATE YARN

Conditions for All Colors	
Nonionic dispersing agent	0.5 g per liter
Low-staining anionic dispersing agent	0.5 g per liter
Ammonium acetate	4% owf
Dyeing temperature	180-190°F
Dyeing time	1¼ hours
Typical Red	*% owf*
Celliton Fast Pink RFG	0.22
Eastman Fast Yellow 4RLF	0.14
Eastman Fast Blue GLF	0.02
Polar Brilliant Red B	0.04
CI 642	0.0325
CI 1088	0.005
Anhydrous sodium sulfate	10
Typical Green	*% owf*
Amacel Yellow CW	0.70
Celliton Fast Pink RFG	0.06
Eastman Fast Blue GLF	0.20
Polar Brilliant Red B	0.0125
CI 642	0.235
CI 1088	0.045
CI 1078	0.045
Anhydrous sodium sulfate	7.5

TABLE VI
SPECIFIC PROCEDURE FOR DYEING WOOL-DYNEL SUITING

Item	*Tan Shade (Brown 1474)*	*Brown (103) Shade*
Material	70% wool-30% Dynel	70% wool-30% Dynel
Assistants	*% owf*	*% owf*
Peregal TW	1.0	1.0
Anhydrous Na_2SO_4	60	60
Bath ratio	30/1	30/1
Dyes	*% owf*	*% owf*
Eastman Fast Yellow 4RLF	0.75	4.0
Eastone Fast Red GLF	0.20	0.9
Eastman Fast Blue GLF	0.27	—
Interchem Acetate Blue B GLF	—	1.0
Irgalan Brown 2 RL	0.41	2.4
Irgalan Olive BGL	0.15	0.8
Irgalan Grey BL	0.06	—
Irgalan Yellow GL	—	0.3
Scour after dyeing (pH 7.2)	*% owf*	*% owf*
Tergitol NPX	2.0	2.0
Calgon	1.0	1.0
Soda ash	0.5	0.5

Dyeing Procedure

1) Prepare dyebath at 80° F with Peregal TW.
2) Add dyes raise temperature to boil in 45 minutes.
3) Run 30 minutes and add sodium sulfate slowly over a period of 15 minutes; run an additional 30 minutes.
4) Continue boiling as needed to secure desired exhaustion (30 minutes).
5) Cool slowly and rinse well with warm water.
6) Scour at 160° F for 20 minutes; rinse well with warm water the final rinse being slightly acidic.

dled as an all-wool fabric in finishing operations, except for the following:

Drying: Dynel is sensitive to elongation if held under tension in the presence of high heat. Therefore, in the drying operation, an overfeed device should be used. The pins should be set narrower, if possible, then the width of the cloth entering the dryer to permit relaxation of the goods. The exact amount of overfeed and minimum width of the pins or clips must be determined in practice in individual mills.

Pressing and Decating: On rotary presses the steam pressure should be not over 40-50 lb when the Dynel component of the blend is over 15 per cent. The jacket-closing pressure should also be opened from the setting used on all-wool goods. Treatment time in decating should be regulated by the amount of set and firmness desired. In general, pieces of Dynel blend will not require as long a treatment time to produce the required finish.

In semidecating the following treatment should be satisfactory in most cases:

Load machine with lowest tension possible.
Steam 2 to 3 minutes after material comes through the roll.
Pump until cool.
Steam pressure = 50 to 60 lb.

To secure maximum dimensional stability in the finished fabric, stretching on a tenter-frame should be avoided.

It will be noted that, for this application, some of the newer neutral-dyeing metallized colors were used on the wool. The post-dyeing scouring agent is nonionic, as recommended in the general procedure.

TABLE VII
SPECIFIC DYEING PROCEDURE AND FASTNESS PROPERTIES OF WOOL-DYNEL HOSIERY YARN

A. Dyeing Materials

Item	*Green 76*	*Maroon 32*	*Grey 19*
Material: 50-50 wool-Dynel			
Assistants	*% owf*	*% owf*	*% owf*
DC Antifoam A	0.1	0.1	0.1
Peregal TW	1.0	1.0	—
Tergitol 4	—	—	1.0
Anhyd Na_2SO_4	60	60	60
Bath ratio	15/1	15/1	15/1
Dyes	*% owf*	*% owf*	*% owf*
Eastone Fast Red GLF	—	2.4	0.04
Eastman F Yellow 4 RLF	3.0	1.2	0.02
Eastman F Blue GLF	—	1.2	0.04
Interchem Acetate Blue BGLF-40	3.0	—	—
Vialon Fast Red G	—	2.8	—
Sulfonine Yellow 5G	0.1	—	—
Aliz Lt Green GSN	1.3	—	—
Scour after dyeing	*% owf*	*% owf*	*% owf*
Tergitol NPX	2.0	2.0	2.0
Calgon	1.0	1.0	1.0
Soda ash	0.5	0.5	0.5

See text for dyeing and finishing procedures.

B. Color Fastness

	Numerical Ratings		
Crocking			
Wet	3	3	5
Dry	4	5	5
Fade-Ometer			
20 hr	no change	v sli change	no change
40 hr	no change	sli change	sli change
Perspiration			
Acid—sample	5	5	5
Acid—test cloth	5	3	5
Alk—sample	5	5	5
Alk—test cloth	5	3	5
Dry Cleaning			
Sample	5	5	5
Test cloth	5	4	5
No. 1 Wool Wash Test			
Sample	5	5	5
Test cloth	4	4	5

(D) PACKAGE-DYED WOOL-DYNEL HOSIERY KNITTING YARN ——— To support the work on piece goods, 3 other shades were dyed on 50% wool-50% Dynel hosiery yarn and knitted into Argyle socks. The shades were a bright maroon, a dark bright green, and a medium-weight grey. Fastness data and detailed dyeing data are listed in Table VII. The package dyeing procedures used were as follows:

Dyeing and Finishing Procedure For Grey Shade

1) Fill machine with water at 130° F and add antifoam.
2) Enter packages, close machine, make up bath to fill machine.
3) Run for a short time inside-out to wet out the packages.
4) Open the machine and load an extra package to each spindle if necessary.
5) Add the acetate dyes dispersed with Tergitol 4. Raise the temperature to 208-210° F. Run 30 minutes with reversal of the liquid flow every 5 minutes.
6) Add sodium sulfate slowly over a period of 30 minutes; run an additional 30 minutes. Cool slowly inside-out to 150° F.
7) Give a running rinse at 150° F for 10 minutes.
8) Scour at 160° F for 30 minutes with Tergitol NPX Calgon, and soda ash (pH 7.2), and rinse well. A small amount of formic acid should be added to the final rinse.
9) Dry at temperatures below 210° F.
10) Hose made from this yarn was boarded at 230-240° F on a Proctor and Schwartz automatic machine employing No. 2 speed.

Dyeing and Finishing Procedure For Green & Maroon Shades

1) Fill the machine with water at 130° F and add antifoam.

2) Adjust the pH to 6.

3) Enter the packages, close the machine, and make up the bath to fill the machine.

4) Run for a short time inside-out to wet out the packages.

5) Open the machine and load an extra package to each spindle if necessary.

6) Add dissolved Vialon dye to the dyebath.

7) Add the acetate dyes dispersed with Peregal TW. Raise the temperature to 208-210° F. Run 30 minutes with reversal of the liquid flow every 5 minutes.

8) Add sodium sulfate slowly over a period of 30 minutes; run an additional 30 minutes. Cool slowly, inside-out, to 150° F.

9) Give a running rinse at 150° F for 10 minutes.

10) Scour at 160° F for 30 minutes with Tergitol NPX, Calgon and soda ash (pH 7.2) and rinse well. A small amount of formic acid should be added to the final rinse.

11) Dry at temperatures below 210° F.

12) Hose made from this yarn was boarded at 230-240° F on a Proctor and Schwartz automatic machine at No. 2 speed.

The deviations from and additions to the general procedure in Part V are inclusion of an antifoam agent to prevent trouble in package dyeing plus the same items listed in the case of the suiting cloths. Neutral-dyeing acid or metallized colors were used for the wool fraction of the yarns. Dyeing was uniform within and between packages. It is concluded from these application trials that union dyeing wool-Dynel piece goods is a practical operation, which can produce finished goods of good colorfastness.

(E) UNION-DYED WOOL-DACRON SUITING———A suiting cloth made of 55% wool and 45% Dacron was piece-dyed to two shades: tan and navy. The fastness test results were excellent, and Table VIII cites the color formulas and procedures. In this case a top-chrome procedure was used for the wool. The dyes worked out very smoothly as to levelness, penetration, etc, and produced cloth of very good hand despite the long liquor ratio employed. It is concluded that the procedure employed, which is entirely included in the general procedure described in Part V, is a practical one.

The applications described in this section have verified the general procedures developed in the previous sections and have resulted in fabrics of union-dyed wool-acetate, wool-Dacron, and wool-Dynel which all have colorfastness adequate for their respective end uses.

TABLE VIII

SPECIFIC PROCEDURE FOR WOOL-DACRON SUITINGS

Item	*Tan*	*Navy*
Material: 55% wool-45% Dacron		
Bath ratio	150/1	150/1
Prescouring agents	*% owf*	*% owf*
Duponal D	2	2
Ammonia	1	1
Assistants	*g/liter*	*g/liter*
Dowicide A Flakes	2.5	5.0
Alkanol DW	0.5	0.5
Glacial acetic acid	1.0	2.0
	% owf	*% owf*
Sodium bichromate	0.5	0.5
Glacial acetic acid	1.0	1.0
Dyes	*% owf*	*% owf*
Latyl Violet B	—	3.90
Latyl Red B	0.140	—
Acetamine F Yellow 4 RL	0.135	—
Latyl Yellow YL	—	1.25
Latyl Blue GE	0.125	1.80
Pontachrome F Red E Conc	0.011	0.60
Anthraquinone Rubine R Conc	—	0.20
Anthraquinone Violet 3 RN	0.024	—
Pontacyl Wool Blue BL 200%	—	0.60
DuPont Neutral Gray L	0.020	—
DuPont Neutral Brown BGL	0.220	—

Procedure

1) Scour 20 minutes at 180° F with Duponol and ammonia. Rinse well and set bath at 110° F.

2) Add separately dissolved Dowicide Flakes, 0.5 g/liter Alkanol DW, and circulate 15 minutes at 110° F. Add 1 g/liter glacial acetic acid and circulate 15 minutes more.

3) Paste Latyl dyes with Alkanol, dilute and add. Add wool dyes.

4) Circulate 15 minutes at 110° F, heat to the boil in 45 minutes, boil 1½ hours.

5) Cool bath to 180° F; add bichromate and 1% acetic acid.

6) Raise to boil, boil 45 minutes, and sample for color.

7) Rinse clear, scour 20 minutes at 180° F with 2% Duponol D and 1% ammonia, rinse, and drop bath.

VII. GENERAL SUMMARY AND CONCLUSIONS

Foremost among the conclusions that the Committee makes is that the problem of dyeing wool combinations containing fibers colored with disperse dyes is successfully answered. Other conclusions may be summarized briefly as follows:

(1) The factors that affect the degree of wool staining by disperse dyes have been isolated as follows:

(a) The nature of the dye. While there are many exceptions, there appears to be a trend for azo dyes to stain more than anthraquinone types as indicated in the table listing those dyes that stained most in Experiment A. This supports the findings of Mellor and Olpin *(6)* but our recommendations differ. The Committee believes that the mere fact of heavier staining is not sufficient basis per se for eliminating the use of azo disperse dyes, since their staining can be modified by the other factors that affect staining. Furthermore, many azo colors have other very desirable properties which overbalance what may not be an important disadvantage, depending upon the nature of the color and the end use fastness required in any given application. It is for this reason that the Appendices give the properties of all disperse dyes, azo and otherwise, for the dyer to interpret in relation to his own particular problem.

(b) The dyebath condition.

(c) The time of dyeing.

(d) The nature and amount of dispersing agents.

(e) Dyeing temperatures.

(f) The cleanliness of the starting materials, particularly in extractable content.

(2) From a synthesis of these factors and other direct information, general dyeing procedures for handling blends of wool-acetate, wool-Dacron, and wool-Dynel were developed.

(3) Inherent in the work is the description of test methods by which anyone with a small laboratory can determine the staining properties of disperse dyes on wool under any set of desired conditions.

(4) A group of practical application trials were made, which demonstrated the validity of the principles determined earlier.

(5) Lastly, a foundation is laid on which future work can be based. While it is demonstrated reasonably well that disperse-dye staining on wool is a surface adsorption effect, the precise mechanism of staining has not been established. The Committee believes that such a study would be fruitful and may lead to even better methods for control of wool staining.

VIII. ACKNOWLEDGMENTS

The Committee expresses sincere thanks to the many persons, both in the participating companies and otherwise, who have assisted in the work reported. We specially thank the following individuals and organizations for important contributions:

Phoenix Hosiery Co, Milwaukee, Wis, for making the wool-Dynel socks,

Paul Studer and George Ward of Celanese for a great deal of detail laboratory work on behavior of disperse dyes,

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V Fedorov of Alex Smith for laboratory and pilot work on wool-acetate unions,

H T Townsley and F C Rippner of Carbide and Carbon for laboratory work, pilot work, and arrangements of plant work on wool-Dynel unions,

J Flint and A Arcus of General Dyestuff for their assistance during the period in which they were able to work with us.

All dyestuff manufacturers for courtesy in supplying disperse-dye samples and information.

APPENDIX A
EVALUATION OF DISPERSE DYES FOR STAINING TENDENCIES ON WOOL

I) Dyes tested and equivalent strengths used:

	Structural Type	*CI or Pr No.*	*Specific Type Used*	*Strength of Dyeing % owf*
1.	anthraquinone red	Pr 234	Celliton Fast Pink BA-CF	1.25
2.	anthraquinone red	Pr 235	Celanthrene F Pink 3B	2.50
3.	anthraquinone red	Pr 370	Celliton Fast Pink RFG	3.75
4.	anthraquinone red	—	Amacel Red 6X	3.75
5.	anthraquinone red	Pr 237	Setacyl Direct Violet R Conc	1.25
6.	azo red	Pr 236	Cibacete Red YNB Ext Conc	0.625
7.	azo red	Pr 238	Setacyl Direct Red 2B	1.10
8.	azo red	Pr 244	Artisil Direct Scarlet GP Conc	0.50
9.	azo red	Pr 239	Cibacete Rubino 3BS	0.60
10.	azo red	Pr 230	Celliton F Brown 3RA Ext CF	0.625
11.	azo red	Pr 231	Celliton F Brown 5RA-CF	1.10
12.	azo red	Pr 61	Cibacete Red 3B	1.375
13.	specialty red	—	Amacel Red FSI	1.875
14.	specialty red	—	Eastone Red GLF	1.50
15.	specialty red	—	Amacel Red 2B	1.25
16.	specialty red	—	Amacel Red Y	1.25
17.	specialty red	—	Celanthrene Violet BGF	2.75
18.	anthr or azo yellow	Pr 242	Artisil Direct Yellow G	0.50
19.	anthr or azo yellow	Pr 243	Acetamine Yellow RR	1.15
20.	anthr or azo yellow	—	Celliton F Yellow 4RL Conc	0.55
21.	anthr or azo yellow	Pr 245	Calcosyn Yellow 5GC Conc	0.55
22.	anthr or azo yellow	Pr 369	Celliton Brill Yellow FFA-CF	0.55
23.	anthr or azo yellow	Pr 420	Celliton Fast Yellow 7G	0.575
24.	anthr or azo yellow	Pr 43	Artisil Direct Orange 2R	0.20
25.	anthr or azo yellow	Pr 174	Setacyl Direct Orange 2R Supra	0.225
26.	anthr or azo yellow	—	Celanthrene F Yellow GL 300%	0.425
27.	anthr or azo yellow	—	Celanthrene Orange Extra	1.25
28.	diphenylamine yellow	—	Amacel Yellow GLF	1.20
29.	diphenylamine yellow	—	Eastman F Yellow 4RLF	1.35
30.	diphenylamine yellow	—	Amacel Yellow CW	1.30
31.	anthraquinone blue	Pr 228	Artisil Direct Blue BSQ	0.50
32.	anthraquinone blue	Pr 229	Cibacete Blue Green C	0.50
33.	anthraquinone blue	—	Celliton Blue BB Ext Conc CF	0.45
34.	anthraquinone blue	Pr 62	Cibacete Sapphire Blue G	0.45
35.	anthraquinone blue	Pr 241	Cibacete Violet B Ext Conc	0.50
36.	specialty blue	—	Celanthrene Fast Blue 2G	0.50
37.	specialty blue	—	Eastman Blue GLF	1.00
38.	specialty blue	—	Artisil Direct Blue GFL	1.00
39.	specialty blue	—	Amacel Blue GLF	1.00
40.	specialty blue	—	Amacel Violet Blue FSI	1.00

Note: For specific applications cited in Part VI a few disperse dyes other than those above were used. Full information on their wool-staining properties is given in the appropriate sections of Part VI or the appendices to which they refer.

II) Dyeing methods in which wool staining tendencies were determined.

Note: All methods were run at 50/1 water/wool ratio. Wool yarn was spun with 2.5% lard oil and was scoured to 0.2% residual oil with nonionic detergent and soda ash before dyeing. The pH of scoured yarn extract was 8.0. All percentages were based on wt of wool fiber.

Method A, neutral

1.	anhydrous sodium sulfate	10%
2.	dyeing temperature	180 F
3.	dyeing time	1 hour
4.	after rinse	cold running water, 30"

Method B, buffered neutral

1.	anhydrous sodium sulfate	10%
2.	ammonium acetate	5%
3.	dyeing time	1 hour
4.	dyeing temperature	180-190° F
5.	after rinse	cold running water, 30"

Method C, mild acid

1.	anhydrous sodium sulfate	10%
2.	glacial acetic acid	2%
3.	dyeing time	1 hour
4.	dyeing temperature	180-190° F
5.	after rinse	cold running water, 30"

Method D, sulfuric acid

1.	anhydrous sodium sulfate	10%
2.	96% sulfuric acid	3%
3.	dyeing time	1 hour
4.	dyeing temperature	180-190° F
5.	after rinse	cold running water, 30"

Method E, metallized-dye procedure

1.	96% sulfuric acid	6%
2.	dyeing time	1 hour
3.	dyeing temperature	200° F
4.	after rinse	cold running water, 30"

Method F, chromate

1.	ammonium acetate	5%
2.	sodium bichromate	1%
3.	raise to boil in 30 min and boil for	½ hr
4.	add acetic acid	5%
5.	boil	½ hr
6.	after rinse	cold running water, 30"

Method G, top chrome

1.	anhydrous sodium sulfate	10%
2.	ammonium sulfate	8%
3.	boil	½ hour
4.	glacial acetic acid	3%
5.	boil	½ hour
6.	sodium bichromate	¾%
7.	boil	½ hour
8.	after rinse	cold running water, 30"

III) Fastness tests made on wool stain produced by disperse dyes.

A) Washing fastness
Test No. 2, AATCC Stand Test Method 36-52
120°F for 30 min in Launder-Ometer with 0.5% soap.

B) Crocking fastness
AATCC Standard Test Method 8-52

APPENDIX A (continued)

IV) Evaluation of disperse dyes for staining properties on wool and fastness of stains, seven dyeing methods.

Note: Light fastness not included in this appendix. See Part V and Appendix B.

40.	specialty blue	Amacel Violet Blue FSI	1.00

Note: For specific applications cited in Part VI a few disperse dyes other than those above were used. Full information on their wool-staining properties is given in the appropriate sections of Part VI or the appendices to which they refer.

III) *Fastness tests made on wool stain produced by disperse dyes.*

A) Washing fastness
Test No. 2, AATCC Stand Test Method 36-52
120°F for 30 min in Launder-Ometer with 0.5% soap.

B) Crocking fastness
AATCC Standard Test Method 8-52

APPENDIX A (continued)

IV) *Evaluation of disperse dyes for staining properties on wool and fastness of stains, seven dyeing methods.*

Note: Light fastness not included in this appendix. See Part V and Appendix B.

Dye & CI or Pr No., if any	Dyeing Method	Description of Stain		Washing Fastness Rating	Crocking Fastness As Dyed Rating	Crocking Fastness Washed Rating
1 Celliton Fast Pink BA-CF	A	bright, weak		2	5	5
	B	duller, sli stronger		2	5	5
Pr 234	C	dull, weak		2	2	5
	D	stronger		3	4	5
	E	strongest		3	4	5
	F	greenish-blue		4	5	5
	G	violet-blue		2	4	5
2 Celanthrene Fast Pink 3B	A	bright, weak		2	5	5
	B	bluer & duller		2	5	5
Pr 235	C	bluer & duller		2	3	5
	D	bluer		3	5	5
	E	blue, strongest		3	4	5
	F	blue & dull		2	5	5
	G	blue & dull		2	4	5
3 Celliton Fast Pink RFG	A	bright, weak		2	5	5
	B	slightly duller		2	4	5
Pr 370	C	duller		2	3	5
	D	yellower, stronger		3	3	4
	E	yellowish, strongest		2	3	4
	F	deep violet		5	5	5
	G	dull & blue		2	4	5
4 Amacel Red 6X	A	bright, weak		2	5	5
	B	dull, weak		2	3	5
	C	dull, weak		2	3	5
	D	yellow, heavier		3	4	4
	E	yellow, dull, heavy		2	4	5
	F	dark, dull		2	5	5
	G	dark, dull		2	5	5
5 Setacyl Direct Violet R Conc	A	bright		2	5	5
	B	bright		2	5	5
Pr 237	C	sli duller	all	2	5	5
	D	sli bluer	same	3	5	5
	E	blue, dull	depth	2	5	5
	F	blue, dull		2	5	5
	G	dull		2	5	5
6 Cibacete Red YNB Ex Conc	A	bright, heaviest		2	5	5
	B	sli weaker		2	5	5
Pr 236	C	sli weaker		2	5	5
	D	weaker		2	5	5
	E	much weaker		2	5	5
	F	yellow, weak		2	5	5
	G	weak		2	5	5
7 Setacyl Direct Red 2B	A	bright, heaviest		2	5	5
	B	brighter		2	5	5
Pr 238	C	weaker		2	5	5
	D	still weaker		2	5	4
	E	very weak		2	5	5
	F	dull		2	5	5
	G	weak		2	5	5
8 Artisil Direct Scarlet GP Conc	A	dull		2	3	5
	B	yellowish		2	4	5
Pr 244	C	yellowish	all	3	3	5
	D	brightest	nearly	2	5	4
	E	sli weaker	same	2	5	5
	F	yellowish	depth	2	4	5
	G	yellowish		2	3	5
9 Cibacete Rubine 3 BS	A	bright		2	5	5
	B	bright		2	4	5
Pr 239	C	sli weaker, duller		2	4	5
	D	sli weaker, duller		2	4	4
	E	much weaker		2	5	5
	F	dull		3	5	5
	G	weak & dull		2	5	5
10 Celliton Fast Brown 3 RA Ex CF	A	bright		2	5	5
	B	bright		2	5	5
Pr 230	C	v sli duller	all	2	5	5
	D	v sli duller	same	2	4	4
	E	sli duller	depth	2	4	5
	F	sli duller		2	5	5
	G	sli duller		2	4	5
11 Celliton Fast Brown 5 RA-CF	A	bright		2	5	5
	B	bright		2	5	5
Pr 231	C	sli duller	all	2	4	5
	D	sli duller	nearly	2	4	4
	E	sli weaker	same	2	4	5
	F	sli dull	depth	2	5	5
	G	sli dull		2	4	5
12 Cibacete Red 3B	A	weak, dull		2	4	5
	B	weak, dull		2	3	5
Pr 61	C	weak, dull	all	2	2	5
	D	bright	nearly	3	4	4
	E	sli duller	same	2	4	5
	F	greenish-blue	depth	4	5	5
	G	violet-blue		2	5	5
13 Amacel Red FSI	A	bright		2	5	5
	B	sli duller, weaker		2	5	5
	C	yellowish	all	2	5	5
	D	yellow, dull	nearly	2	4	4
	E	bluer, dull	same	2	4	5
	F	bluer, dull	depth	2	5	5
	G	yellow, dull		1	4	5
14 Eastone Red GLF	A	bright		2	5	5
	B	sli duller		2	4	5
	C	sli yellowish	all	2	4	5
	D	yellower	same	2	4	4
	E	yellower	depth	2	4	5
	F	yellow & dull		2	4	5
	G	yellowish		2	4	5
15 Amacel Red 2B	A	bright, heaviest		2	5	5
	B	yellower, duller		2	4	5
	C	yellower, duller		2	4	5
	D	much yellower, duller		2	4	4
	E	much yellower, weaker		2	4	5
	F	dull, dark		2	4	5
	G	yellowish		2	4	5
16 Amacel Red Y	A	bright, heaviest		2	4	5
	B	sli duller		2	4	5
	C	duller, weaker		2	4	5
	D	yellow, weaker		2	5	4
	E	very weak		2	5	5
	F	dull, yellow		2	5	5
	G	dull, bluish		2	5	5
17 Celanthrene Violet BGF	A	bright		2	5	5
	B	sli redder, duller		2	4	5
	C	duller	all	2	4	5
	D	duller, redder	nearly	3	4	5
	E	duller, sl stronger	same	3	2	4
	F	blue-green	depth	5	5	5
	G	greener, stronger		3	4	5

APPENDIX A (continued)

Dye & CI or Pr No., if any	Dyeing Method	Description of Stain		Washing Fastness Rating	Crocking Fastness As Dyed Rating	Crocking Fastness Washed Rating
18 Artisil Direct Yellow G Pr 242	A	bright	all	2	5	5
	B	duller, greener	nearly	2	5	5
	C	duller	same	2	5	5
	D	sli weaker	depth	2	5	5
	E	sli duller		2	5	5
	F	reddish-brown		2	5	5
	G	reddish		2	5	5
19 Acetamine Yellow RR Pr 243	A	bright	all	2	5	5
	B	bright	nearly	2	5	5
	C	v sli duller	same	2	5	5
	D	sl weaker	depth	2	5	5
	E	sl weaker		2	5	5
	F	reddish, dull		3	5	5
	G	reddish, dull		2	5	5
20 Celliton Fast Yellow 4 RL Conc	A	bright	all	3	5	5
	B	sli duller	nearly	3	5	5
	C	sli duller, greener	same	3	5	5
	D	sli greener	depth	4	4	4
	E	greener		4	5	5
	F	reddish, dull		3	5	5
	G	dull		3	4	4
21 Calcosyn Yellow 5 GC Conc Pr 245	A	reddish	all	2	5	5
	B	brightest	nearly	2	5	5
	C	sli duller	same	2	5	5
	D	sli duller	depth	2	5	5
	E	sli duller		3	5	5
	F	duller, reddish		4	5	5
	G	duller, reddish		2	5	5
22 Celliton Brill Yellow FFA-CF Pr 369	A	bright	all	2	5	5
	B	bright	nearly	2	5	5
	C	sli duller	same	3	5	5
	D	sli weaker	depth	4	5	5
	E	sli duller		3	5	5
	F	dull, greenish		2	5	5
	G	dull, reddish		2	5	5
23 Celliton Fast Yellow 7G Pr 420	A	weak	all	1	5	5
	B	duller	nearly	2	5	5
	C	duller	same	1	5	5
	D	greener	depth	2	5	4
	E	redder		2	5	5
	F	dull, green		2	5	5
	G	dull, reddish		1	5	5
24 Artisil Direct Orange 2R Pr 43	A	bright	all	2	5	5
	B	bright	nearly	2	5	5
	C	sli. duller	same	2	5	5
	D	yellowish	depth	3	5	5
	E	yellowish		3	5	5
	F	dull		2	5	5
	G	sli weaker		2	5	5
25 Setacyl Direct Orange 2R Supra Pr 174	A	bright		2	5	5
	B	bright		2	5	5
	C	duller		2	5	5
	D	sli weaker		3	5	4
	E	much weaker		3	5	5
	F	dull		2	5	5
	G	dull		2	5	5
26 Celanthrene Fast Yellow GL Conc 300%	A	bright	all	2	5	5
	B	redder	same	2	5	5
	C	redder	depth	2	4	5
	D	greener		2	5	5
	E	greener		2	5	5
	F	dull, greenish		2	5	5
	G	sli reddish		2	5	5
27 Celanthrene Orange Extra	A	dull	all	2	5	5
	B	dull	nearly	2	4	5
	C	dull, bluish	same	2	3	5
	D	brightest	depth	2	5	5
	E	sli duller		2	4	5
	F	dull		2	5	5
	G	dull		2	4	5
28 Amacel Yellow GLF	A	bright	same	2	5	5
	B	bright	depth	2	5	5
	C	sli duller	all	2	5	5
	D	sli duller		2	5	5
	E	sli redder		2	5	5
	F	dull, greenish		2	5	5
	G	dull, reddish		2	5	5
29 Eastman Fast Yellow 4 RLF	A	bright	all	2	5	5
	B	bright	same	2	5	5
	C	duller	depth	2	5	5
	D	sli dull		3	4	4
	E	sli dull		2	5	5
	F	dull, greenish		2	5	5
	G	sli dull		2	5	5
30 Amacel Yellow CW	A	bright, light		2	5	5
	B	bright, light		2	5	5
	C	duller, greener, heavier		2	5	5
	D	duller, redder, heavier		3	4	3
	E	red, dull, heavy		2	4	4
	F	dull, greenish		2	5	5
	G	dull, reddish		2	4	5
31 Artisil Direct Blue BSQ Pr 228	A	bright	all	2	5	5
	B	sli duller	same	2	5	5
	C	sli redder	depth	2	5	5
	D	sli duller		3	5	4
	E	redder		2	5	5
	F	much greener		2	5	5
	G	sli reddish		2	5	5
32 Cibacete Blue Green C Pr 229	A	bright	all	2	5	5
	B	bright	same	2	5	5
	C	sli duller, redder	depth	2	5	5
	D	sli duller		3	5	4
	E	dull		3	5	5
	F	greenish		4	5	5
	G	greenish		2	5	5
33 Celliton Blue BB Ext Conc CF	A	bright, heaviest		2	5	5
	B	sli weaker		2	5	5
	C	weaker		3	5	5
	D	greener		4	5	4
	E	weak, greenish		4	5	5
	F	green, dull		4	5	5
	G	green, dull		3	5	5

APPENDIX A (concluded)

Dye & CI or Pr No., if any	Dyeing Method	Description of Stain		Washing Fastness Rating	Crocking Fastness As Dyed Rating	Crocking Fastness Washed Rating
34 Celliton Blue BB Ext Conc CF	A	bright, heaviest	all	2	5	5
	B	sli weaker	nearly	2	5	5
	C	weaker	same	3	5	5
	D	greener	depth	4	5	4
	E	weak, greenish		4	5	5
	F	green, dull		4	5	5
	G	green, dull		3	5	5
35 Celliton Blue BB Ext Conc CF	A	bright, heaviest	all	2	5	5
	B	sli weaker	nearly	2	5	5
	C	weaker	same	3	5	5
	D	greener	depth	4	5	4
	E	weak, greenish		4	5	5
	F	green, dull		4	5	5
	G	green, dull		3	5	5
36 Celliton Blue BB Ext Conc CF	A	bright, heaviest	all	2	5	5
	B	sli weaker	nearly	2	5	5
	C	weaker	same	3	5	5
	D	greener	depth	4	5	4
	E	weak, greenish		4	5	5
	F	green, dull		4	5	5
	G	green, dull		3	5	5

APPENDIX B

DEPTH AND FASTNESS RATINGS OF WOOL STAINS,

	Pr 174	C	duller	2	5	5
		D	sli weaker	3	5	4
		E	much weaker	3	5	5
		F	dull	2	5	5
		G	dull	2	5	5

		B	sli weaker	2	5	5
		C	weaker	3	5	5
		D	greener	4	5	4
		E	weak, greenish	4	5	5
		F	green, dull	4	5	5
		G	green, dull	3	5	5

APPENDIX A (concluded)

	Dye & CI or Pr No., if any	Dyeing Method	Description of Stain		Washing Fastness Rating	Crocking Fastness As Dyed Rating	Crocking Fastness Washed Rating
34	Cibacete Sapphire Blue G	A	bright, heaviest		2	5	5
		B	greener		2	5	5
	Pr 62	C	greener, weaker		3	5	5
		D	greener, weaker		5	5	4
		E	greenish, weak		3	5	5
		F	dull, dark		4	5	5
		G	greenish		4	5	5
35	Cibacete Violet B Ex Conc	A	bright		2	5	5
		B	sli duller	all	2	5	5
	Pr 241	C	sli duller	nearly	2	5	5
		D	duller, sl weak	same	2	5	5
		E	dull	depth	2	5	5
		F	green, dull		2	5	5
		G	green, dull		2	5	5
36	Celanthrene Fast Blue 2G	A	bright		2	5	5
		B	bright		2	5	5
		C	sli redder	all	2	5	5
		D	sli duller	same	2	5	4
		E	sli duller, redder	depth	2	5	5
		F	green		4	5	5
		G	greenish		2	5	5
37	Eastman Blue GLF	A	dark		2	3	5
		B	dark, bright		2	4	5
		C	dark, bright	all	3	4	5
		D	dark, bright	same	3	3	3
		E	dark, bright	depth	3	3	4
		F	green		5	5	5
		G	greenish		3	4	5
38	Artisil Direct Blue GFL	A	very heavy		4	5	5
		B	brighter		4	5	5
		C	duller	all	5	5	5
		D	v sli redder	nearly	5	5	4
		E	dark, red	same	5	5	5
		F	dark, greener	depth	5	5	5
		G	darker		4	5	5
39	Amacel Blue GLF	A	bright		2	1	5
		B	sli duller		2	5	5
		C	duller, greener	all	2	3	5
		D	duller, greener	same	2	3	3
		E	duller, greener	depth	2	3	4
		F	duller, greener		2	5	5
		G	duller, greener		2	3	5
40	Amacel Violet Blue FSI	A	weak		2	5	5
		B	brighter, stronger		2	5	5
		C	sli weaker		2	3	5
		D	redder, stronger		2	2	2
		E	greener, still stronger		2	2	4
		F	greenish, dull		2	4	5
		G	greenish, dark		2	2	5

APPENDIX B

DEPTH AND FASTNESS RATINGS OF WOOL STAINS, DISPERSE DYES ON 50/50 WOOL/ACETATE, NEUTRAL DYED

Notes: 1) For fastness rating of disperse dyes on acetate, see manufacturers' shade cards.
2) For wash fastness of wool stains, see Appendix A.
3) All dyeings on 50% wool and 50% acetate at 50/1 water/fiber ratio for 1 hour at 185°F. Baths contained 5% ammonium acetate, 0.5 g per liter nonionic dispersing agent and 0.5 g per liter low-staining anionic dispersing agent.

	Pr No.	Specific Type	% Dye on Total Fiber	Depth of Stained Wool	10 Hours Fade-Ometer Wool Stain
1	234	Celliton F Pink BA-CF	0.63*	mh**	3***
2	235	Celanthrene F Pink 3B	1.30	mh	5
3	370	Celliton F Pink RFG	1.90	mh	4
4	—	Amacel Red 6X	1.90	h	3
5	237	Setacyl Dir Violet R	0.63	l	5
6	236	Cibacete Red YNB Ex Conc	0.32	h	2
7	238	Setacyl Dir Red 2B	0.55	h	1
8	244	Artisil Dir Scarlet GP	0.25	h	2
9	239	Cibacete Rubine 3 BS	0.30	vh	1
10	230	Celliton F Brown 3 RA Ex CF	0.32	h	1
11	231	Celliton F Brown 5 RA-CF	0.55	vh	1
12	61	Cibacete Red 3B	0.69	mh	2
13	—	Amacel Red FSI	0.94	mh	4
14	—	Eastone Red GLF	0.75	h	1
15	—	Amacel Red 2B	0.63	vh	2
16	—	Amacel Red Y	0.63	h	2
17	—	Celanthrene Violet BGF	1.38	l	2
18	242	Artisil Dir Yellow G	0.25	mh	5
19	243	Acetamine Yellow RR	0.60	mh	1
20	—	Celliton F Yellow 4 RL Conc	0.28	vh	5
21	245	Calcosyn Yellow 5 GC Conc	0.28	l	4
22	369	Celliton Brill Yellow FFA-CF	0.28	h	1
23	420	Celliton F Yellow 7G	0.30	mh	4
24	43	Artisil Dir Orange 2R	0.10	l	1
25	174	Setacyl Dir Orange 2R Supra	0.12	mh	1
26	—	Celanthrene F Yellow GL 300%	0.22	vl	5
27	—	Celanthrene Orange Extra	0.63	mh	4
28	—	Amacel Yellow GLF	0.60	mh	4
29	—	Eastman F Yellow 4 RLF	0.68	mh	5
30	—	Amacel Yellow CW	0.68	l	5
31	228	Artisil Direct Blue BSQ	0.25	mh	2
32	229	Cibacete Blue Green C	0.25	l	4
33	—	Celliton Blue BB Ext Conc CF	0.23	mh	2
34	62	Cibacete Sapphire Blue G	0.23	h	4
35	241	Cibacete Violet B Ext Conc	0.25	h	2
36	—	Celanthrene F Blue 2G	0.25	l	5
37	—	Eastman Blue GLF	0.50	h	2
38	—	Artisil Direct Blue GLF	0.50	vh	2
39	—	Amacel Blue GLF	0.50	l	2
40	—	Amacel Violet Blue FSI	0.50	l	4

All wool stains had rating of 5 for crocking and showed no change of shade upon exposure to 2 cycles of gas fading.

* Dye strengths adjusted to yield equivalent color values on acetate.

** *code, depth of wool stain*
vl, very light
l, light
mh, moderately heavy
h, heavy
vh, very heavy

*** *code, light fastness of stain*
1, almost faded out
2, severe change
3, appreciable change
4, slight change
5, no change or just perceptible change

APPENDIX C
THE PROPERTIES OF DISPERSED DYES APPLIED TO 50/50 WOOL/DYNEL MIXTURE

I) *Results of first screening, all dyes. See Item II for dyeing procedures.*

Test No.	Dye	Relative Shades of wool & Dynel		Crocking Fastness, Ratings								Light Fastness, 10 hour Fade-Ometer			
				Not chromed				Chromed				Not chromed		Chromed	
				Wool		Dynel		Wool		Dynel					
		Not Chromed	Chromed	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wool	Dynel	Wool	Dynel
1	Celliton Fast Pink BA-CF	*1*	*1*	3	4	5	5	3	4	5	5	C	SC	VSC	C
2	Celanthrene Fast Pick 3B	*1*	*3*	3	4	5	5	3	4	5	5	SC	SC	SC	C
3	Celliton Fast Pink RFG	*1*	*2*	3	4	5	5	4	5	5	5	SC	VSC	NC	VSC
4	Amacel Red 6X	*4*	*3*	3	4	4	4	3	4	5	5	C	C	SC	C
5	Setacyl Direct Violet R Conc	*4*	*2*	5	5	5	5	5	5	5	5	SC	C	SC	C
6	Cibacete Red YNB Ext Conc	*4*	*4*	3	3	5	5	3	4	5	5	C	C	C	C
7	Setacyl Direct Red 2B	*4*	*4*	3	3	5	5	3	3	5	5	C	C	C	C
8	Artisil Direct Scarlet GP Conc	*1*	*1*	3	4	5	5	4	4	5	5	C	SC	C	SC
9	Cibacete Rubine 3BS	*4*	*4*	4	4	5	5	4	5	5	5	C	C	C	C
10	Celliton Fast Brown 3RA Ext Conc	*1*	*1*	4	5	5	5	4	5	5	5	C	SC	C	SC
11	Celliton Fast Brown 5RA-CF	*1*	*1*	3	4	5	5	4	4	5	5	C	SC	C	SC
12	Cibacete Red 3B	*1*	*2*	3	4	5	5	4	5	5	5	C	VSC	SC	SC
13	Amacel Red FSI	*1*	*3*	3	4	5	5	4	5	5	5	C	SC	VSC	C
14	Eastone Fast Red GLF	*4*	*2*	4	4	4	5	4	5	5	5	C	SC	C	SC
15	Amacel Red 2B	*1*	*2*	2	3	4	5	3	4	5	5	C	C	SC	C
16	Amacel Red Y	*4*	*3*	3	3	5	5	4	4	5	5	SC	C	C	C
17	Celanthrene Violet BGF	*1*	*2*	4	5	5	5	4	5	4	4	C	VSC	C	VSC
18	Artisil Direct Yellow G	*1*	*2*	4	5	5	5	4	5	4	5	C	C	C	C
19	Acetamine Yellow RR	*4*	*2*	5	5	5	5	4	5	5	5	C	C	VSC	C
20	Celliton Fast Yellow 4RL Conc	*4*	*2*	3	5	5	5	4	5	5	5	SC	NC	SC	NC
21	Calcosyn Yellow 5GC Conc	*1*	*2*	4	5	5	5	4	5	5	5	C	C	C	C
22	Celliton Brilliant Yellow FFA-CF	*4*	*2*	5	5	5	5	4	5	5	5	SC	C	SC	C
23	Celliton Fast Yellow 7 GA Conc	*1*	*2*	4	4	5	5	4	5	5	5	C	C	C	C
24	Artisil Direct Orange 2R Conc	*1*	*2*	4	5	5	5	4	5	5	5	C	C	C	C
25	Setacyl Direct Orange 2R Supra	*1*	*2*	5	5	5	5	4	5	5	5	C	C	SC	C
26	Celanthrene Fast Yellow GL Conc 300	*1*	*1*	4	5	5	5	4	5	5	5	SC	NC	SC	NC
27	Celanthrene Orange Ext	*1*	*2*	5	5	5	5	4	5	5	5	SC	VSC	VSC	VSC
28	AmacelYellow GLF	*4*	*2*	4	5	5	5	4	5	5	5	NC	NC	NC	NC
29	Eastman Fast Yellow 4RLF	*4*	*2*	4	5	5	5	4	5	5	5	SC	NC	SC	NC
30	Amacel Yellow CW	*1*	*2*	4	5	5	5	4	4	5	5	SC	NC	SC	NC
31	Artisil Direct Blue BSQ	*1*	*2*	4	5	5	5	4	5	5	5	C	C	NC	C
32	Cibacete Blue Green C	*4*	*2*	4	4	4	4	3	5	4	5	C	C	SC	C
33	Celliton Blue BB Ext Conc CF	*4*	*2*	4	5	5	5	3	5	4	5	C	C	NC	C
34	Cibacete Sapphire Blue G Ext Conc	*4*	*2*	4	4	5	5	3	5	5	5	SC	C	NC	C
35	Cibacete Violet B Ext Conc	*1*	*2*	4	5	5	5	5	5	5	5	SC	C	SC	SC
36	Celanthrene Fast Blue 2G	*4*	*2*	4	5	5	5	4	5	5	5	SC	C	VSC	C
37	Eastman Fast Blue GLF	*1*	*2*	4	5	4	5	4	5	5	5	SC	NC	NC	NC
38	Artisil Direct Blue GFL	*3*	*5, 2*	4	5	5	5	4	5	5	5	VSC	C	SC	C
39	Amacel Blue GLF	*1*	*2*	3	5	5	5	4	5	5	5	C	SC	SC	C
40	Amacel Violet Blue FSI	*1*	*2*	4	5	5	5	4	5	5	5	C	VSC	VSC	VSC
41	Eastman Fast Violet 4R GLF	*1*	*2*	4	5	5	5	5	5	4	5	C	SC	SC	SC
42	Capracyl Brown RD	*1*	*5, 2*	5	5	5	5	5	4	5	5	NC	NC	NC	NC
43	Vialon Fast Red G	*5*	*5*	4	3	5	4	4	3	5	4	NC	NC	NC	NC
44	Interchem Acetate Blue BGLF-40	*4*	*2*	3	2	5	5	4	3	5	5	C	NC	NC	NC

1 Dynel is dyed to much deeper shade than the wool.
2 Drastic change occurs in the shade of the wool.
3 Wool is not changed in shade, but shade is deeper.
4 The shade obtained on the two fibers is close enough to permit union dyeing of stock-blended materials.
5 Wool is dyed to much deeper shade than Dynel.

Light-Fastness Rating Legend
NC = No change
VSC = Very slight change
SC = Slight change
C = Change

II) *Dyeing Procedures*

Each dye was applied to two skeins of wool and two skeins of Dynel. The dye bath composition was as follows:

Bath ratio, 50/1
Dyeing time, one hour
Assistants, 5% glacial acetic acid
10% Glauber's salt
Temperature, 210°F

At the end of one hour, one each of the skeins was removed, rinsed at 80°F, scoured at 120°F with soap and Calgon, rinsed and dried. These samples are referred to in Table I as dyed, scoured and dried.

The remaining two skeins were placed in a fresh bath of the following composition:

Bath ratio, 50/1
Dyeing time, forty-five minutes
Dyeing temperature, 210°F
Assistants, 0.75% sodium dichromate hydrate, owf
5% glacial acetic acid, owf

At the end of 45 minutes, the two skeins were removed, rinsed at 80°F, scoured at 120°F with soap and Calgon, rinsed and dried. These samples are referred to in Table I as dyed, chromed, scoured and dried.

A preliminary run was made with Purasist RA dissolved in isopropanol (2% owf) with four of the group of dyes. Color yield was not increased with these dyes by using the swelling agent, so this assistant was not used. The presence of Purasist did not affect the pH of the dyebath.

APPENDIX C (continued)

III) *Longer light tests on selected dyeings from above, Dynel only*

APPENDIX C (continued)

III) *Longer light tests on selected dyeings from above, Dynel only*

Test No.	Dye	Fade-Ometer Exposure, Hours 10	20	40
3	Celliton Fast Pink RFG	VSC	VSC	SC
12	Cibacete Red 3B	VSC	SC	C
17	Celanthrene Voilet BGF	VSC	VSC	SC
20	Celliton Fast Yellow 4RL Conc	NC	SC	C
26	Celanthrene Fast Yellow GL Conc 300%	NC	NC	VSC
27	Celanthrene Orange Ext	VSC	SC	C
28	Amacel Yellow GLF	NC	NC	VSC
29	Eastman Fast Yellow 4RLF	NC	VSC	VSC
30	Amacel Yellow CW	NC	NC	VSC
37	Eastman Fast Blue GLF	NC	NC	VSC
40	Amacel Violet Blue FSI	VSC	VSC	C
42	Capracyl Brown RD	NC	NC	VSC
43	Vialon Fast Red G	NC	NC	NC
44	Interchem Acetate Blue BGLF	NC	NC	VSC

NC = no change
VSC = very slight change
SC = slight change
C = change

IV) Fastness Properties of a 50-50 Dynel-Wool Blend Dyed with Selected Disperse Colors—See Item V for dyeing procedure

Test No.	Dye	Dyestuff Conc % owf	Fade-Ometer Exposure, Hours 10	20	30	40	AATCC 15-52 Alkaline Perspiration Rating Color	Cloth	AATCC 38-52 #1 Wool Wash Rating Color	Stain	AATCC 36-52 #2 Wash Test 120°F Rating Color	Stain
3	Celliton Fast Pink RFG	3.25	NC	VSC	SC	—	5	4	1	4	3	2
		6.50	NC	VSC	VSC	—	5	3	1	4	3	2
12	Cibacete Red 3B	1.375	VSC	C	—	—	5	4	1	4	3	3
		2.75	NC	SC	—	—	5	3	1	3	3	3
17	Celanthrene Violet BGF	2.75	VSC	SC	—	—	5	5	—	—	3	4
		5.5	NC	VSC	—	—	5	4	—	—	3	4
20	Celliton Fast Yellow 4RL Conc	0.55	NC	VSC	SC	C	5	4	—	—	3	4
		1.10	NC	NC	VSC	SC	5	4	—	—	3	4
26	Celanthrene Fast Yellow GL Conc 300%	0.425	NC	NC	VSC	VSC	5	4	—	—	3	4
		0.85	NC	NC	VSC	SC	5	3	1	4	3	3
28	Amacel Yellow GLF	1.2	NC	NC	NC	VSC	5	4	—	—	3	4
		2.4	NC	NC	NC	VSC	5	3	1	4	3	3
29	Eastman Fast Yellow 4RLF	1.35	NC	NC	VSC	VSC	5	4	—	—	3	4
		2.70	NC	NC	NC	VSC	5	3	—	—	3	5
30	Amacel Yellow CW	1.3	NC	NC	VSC	VSC	5	5	—	—	3	5
		2.6	NC	NC	NC	VSC	5	4	—	—	3	5
37	Eastman Fast Blue GLF	1.0	NC	VSC	SC	—	5	5	—	—	3	4
		2.0	NC	VSC	SC	—	5	5	—	—	3	4
40	Amacel Violet Blue FSI	1.0	SC	C	—	—	5	5	—	—	3	4
		2.0	VSC	SC	—	—	5	5	—	—	3	3
42	Capracyl Brown RD	0.5	NC	NC	VSC	VSC	5	5	—	—	3	5
		1.0	NC	NC	VSC	VSC	5	5	—	—	3	5
43	Vialon Fast Red G	1.0	NC	NC	VSC	SC	5	5	—	—	3	5
		2.0	NC	NC	NC	VSC	5	5	—	—	3	5
44	Interchem Acetate Blue BGLF	0.8	NC	VSC	SC	—	5	5	—	—	3	5
		1.6	NC	VSC	VSC	—	5	5	—	—	3	4

NC = no change
VSC = very slight change
SC = slight change
C = change

V) *Dyeing procedure for data in Item IV*

Thirteen dyes were applied to a stock-blended yarn of fifty per cent wool, fifty per cent Dynel. Only colors which had shown at least ten hours' light fastness on wool were used for this work. Two concentrations of dyestuff were used: the original amount recommended for each color and twice that amount. Fastness of these dyeings to 10, 20, and 30 hours' Fade-Ometer exposure, alkaline perspiration and washing is recorded in Table I.

All dyeings were made with 1.0% Peregal TW and 60 per cent anhydrous sodium sulfate owf and at a 30/1 bath ratio. The sodium sulfate was added thirty minutes after reaching a boil and total dyeing time was one hour.

A fairly rigorous scouring after dyeing contributes to better fastness properties of the dyed material by removing most of the unfixed color from the wool. The scouring bath was made up with 2% Tergitol NPX, 1% Calgon and 0.5% soda ash. The pH of this scouring bath was 7.2. The material was scoured at 160°F for twenty minutes, rinsed well, and the final rinse was made acidic with sulfuric acid.

APPENDIX D

PROPERTIES OF DISPERSE DYES ON 50/50 WOOL/ DACRON BLEND

I) *Depth of wool stain and fastness properties on wool and Dacron—See Item II for dyeing procedures*

Test No.	Dye	Depth of Wool Stain	40 Hours' Fade-Ometer, Ratings Acid Process Wool	Acid Process Dacron	Chrome Process Wool	Chrome Process Dacron	Sublimation Dacron Rating
1	Celliton F Pink BA-CF	vl	4	4	*	5	1
2	Celanthrene F Pink 3B	vl	3	3	4	4	1
3	Celliton F Pink RFG	vl	3	5	*	5	1
4	Amacel Red 6X	—	—	1	—	1	1
5	Setacyl Direct Violet R Conc	l	3	3	3	3	1
6	Cibacete Red YNB Ext Conc	—	—	1	—	1	3
7	Setacyl Direct Red 2B	—	—	1	—	1	5
8	Artisil Direct Scarlet GP Conc	—	—	1	—	1	3
9	Cibacete Rubine 3BS	—	—	1	—	1	5
10	Celliton F Brown 3RA Ext Conc	—	—	1	—	1	5
11	Celliton F Brown 5RA-CF	—	—	1	—	1	5
12	Cibacete Red 3B	vl	4	5	*	4	1
13	Amacel Red FSI	mh	4	5	*	4	1
14	Eastone Red GLF	—	—	2	—	1	5
15	Amacel Red 2B	—	—	1	—	1	5
16	Amacel Red Y	—	—	1	—	1	5
17	Celanthrene Violet BGF	mh	4	5	*	5	5
18	Artisil Direct Yellow G	vl	4	5	*	4	1
19	Acetamine Yellow RR	—	—	1	—	1	5
20	Celliton F Yellow 4RL Conc	vl	4	5	5	5	3
21	Calcosyn Yellow 5GC Conc	vl	3	3	*	3	5
22	Celliton Brill Yellow FFA-CF	—	—	1	—	1	5
23	Celliton F Yellow 7G	—	—	1	—	1	1
24	Artisil Direct Orange 2R	—	—	1	—	1	1
25	Setacyl Direct Orange 2R Supra	—	—	1	—	1	1
26	Celanthrene F Yellow GL 300%	vl	5	5	4	4	1
27	Celanthrene Orange Extra	—	—	1	—	1	1
28	Amacel Yellow GLF	l	4	5	5	5	5
29	Eastman F Yellow 4 REF	l	5	5	4	4	5
30	Amacel Yellow CW	mh	5	5	4	4	5
31	Artisil Direct Blue BSQ	—	—	1	—	1	3
32	Cibacete Blue Green C	—	—	1	—	1	5
33	Celliton Blue BB 7Ext Conc CF	—	—	1	—	1	5
34	Cibacete Sapphire Blue G	—	—	1	—	1	5
35	Cibacete Violet B Ext Conc	—	—	1	—	1	5
36	Celanthrene F Blue 2G	—	—	1	—	1	5
37	Eastman Blue GLF	mh	4	5	4	4	5
38	Artisil Direct Blue GFL	—	—	1	—	1	5
39	Amacel Blue GLF	—	—	1	—	1	5
40	Amacel Violet Blue FSI	—	—	1	—	1	5
45	Latyl Orange R	mh	5	5	5	5	1
46	Latyl Blue GE	l	5	5	*	5	5
47	Latyl Brill Blue 2G	l	5	5	*	5	5
48	Latyl Violet B	l	5	5	*	5	5
49	Latyl Violet 2R	l	5	5	*	5	5
50	Latyl Red B	l	5	5	*	5	3

Code, Depth of Wool Stain
vl, very light
l, light
mh, moderately heavy
h, heavy
vh, very heavy

Light (ratings 1-5)
* changed color markedly in chroming

Sublimation Test
20 minutes' exposure of Dacron only, otherwise as AATCC Temp Test Method 58-52

Crocking Test
AATCC Std Test Method 8-52. All ratings for Dacron, both wet and dry, were "5".

II) *Dyeing procedures*

A) Acid process
1) make up dyebath with dye,* 5 g/liter sodium orthophenyl phenate and 1 g/liter sulfuric acid;
2) enter yarn, boil 1½ hours;
3) drop bath, rinse yarn and scour with 2% fatty alcohol sulfate detergent 15 minutes at 160°F;
4) rinse yarn again and dry.

B) Top-chrome process
1), 2), steps (1) and (2) as above;
3) add 5% acetic acid, 1% chrome, boil 1 hour;
4), 5) same as steps (3) and (4), above.

* Dye concentrations were same as in App B, except Latyl colors, which were applied at 0.5% owf.

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PNEUMATIC MANGLE SOLVES MANY DYEHOUSE PROBLEMS

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THE interrelated effects of squeeze-roll diameter, density and loading have always constituted a vicious circle in textile wet-finishing machinery. Rolls loaded at their journals have a natural tendency to deflect. Fixed correction for a particular service condition may be made by crowning, or by skewing one roll with respect to another, both at the expense of versatility. Deflection may be decreased by increasing the roll diameter, and softer roll coverings will compensate for deflection to a limited degree. However, the increase in contact area resulting from larger diameter or softer covering reduces the *unit pressure,* or pounds exerted on each square inch of fabric.

Just as the Indian fakir can distribute his weight upon a bed of sharp spikes, any one of which alone would pierce his flesh, a wide contact band between rolls takes the effective "bite" from a pair of nip rolls.

In the discussion of squeeze rolls, the word "pressure" has been universally misused. Although defined as "force exerted per unit of area," the term has been incorrectly used to describe the *total* nip loading, and also the force per *lineal* inch of nip. Actually, neither value alone is significant in rating the performance of a squeezer or padder. It is the *unit pressure* (pounds per square inch in the actual contact area) which counts, and this depends upon loading, roll diameters, and surface characteristics.

C Amidon

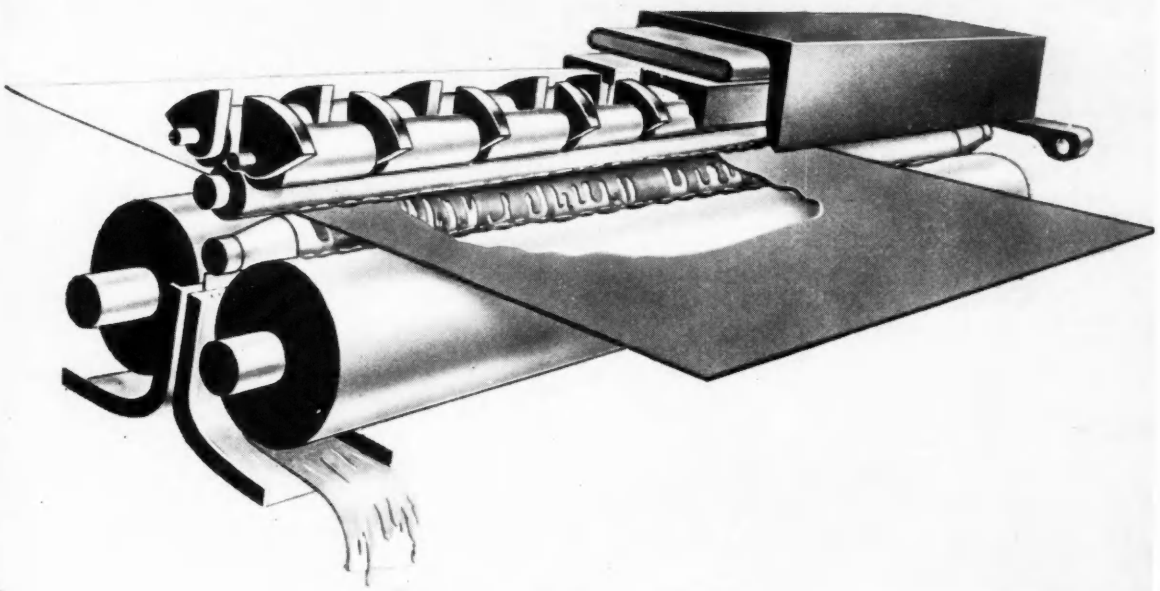
PERFORMANCE FEATURES———A list of essential features for any extractor, mangle or padder would certainly include the following:

1) Pressure must be *uniformly applied* across the nip.
2) Loading must be *resilient* to allow seams or various thicknesses to pass through the nip without damage to fabric or rolls.
3) *Unit pressure* must be correct for fabric and process with convenient control.
4) *Roll surface* must conform to the fabric, but without damaging or stretching the fabric.

The Niptrol* Pneumatic Mangle is designed to offer an optimum combination of these features in an efficient and versatile package. The pressure system consists of an inflated tube confined in a rigid transverse channel, and transmitting its evenly distributed pressure through a flexible steel plate bearing against self-adjusting brackets to staggered, short-face pressure rolls. These pressure rolls apply their evenly distributed forces to the small diameter, stainless steel top nip roll. The pneumatic tube is an ideal arrangement for effecting an even, resilient, controlled squeeze.

The lower primary nip roll, or "soft" roll, is cradled between two rigid support rolls, permitting the use of a small diameter "soft" roll. Three nips are formed —

* Trademark of Rodney Hunt Machine Company.



Schematic drawing of the Niptrol Pneumatic Mangle

the primary or "sharp" nip between the stainless steel roll and the "soft" roll, and the two secondary nips between "soft" and the hard-rubber-covered support rolls. Due to the small diameters of the primary nip rolls, the nip contact area is extremely small. Actual measurement shows an even contact band 3/16" wide across the full machine width.

The Niptrol pneumatic system produces a maximum loading of 250 pounds per *lineal* inch at 43 psi air pressure. With the 3/16" contact band, this is equivalent to 1333 pounds per square inch on the fabric. The total load on a Niptrol for 64" fabric would be 17250#. On the other hand, a conventional heavy duty extractor, or padder with 18" or 20" diameter rolls and 30,000# total loading, usually has a contact band between rolls at least ½" wide. For a 70" roll face, this is equivalent to 429 pounds per lineal inch, and only 858 pounds per square inch, on the fabric.

The special construction of the "soft" roll has an important function in the Niptrol machine. The synthetic material used in this roll, as prepared, has the ability to conform closely to the weave or pattern of a fabric, yielding readily to accommodate the individual yarns, while filling the interstices to exclude water pockets. The narrow contact band allows the effluent to escape the nip easily. Resulting extraction corresponds closely to the "swell points," or natural moisture content of the fabric.

The action of the "soft" roll is gentle, since distortion occurs only in the surface layer. Below the surface the material presents increasing resistance. The material does not "creep" and distort, and stretch on spun rayon has been measured at 2 percent.

DESIGN FEATURES——The mechanical design and arrangement of the Niptrol are unusual. The rugged interchangeable end-frame castings act as housings for the various combinations of available drive, and the machine can be equipped with a drive for extraction alone or for extraction and starching, or for resin application. For multiple drive a quick-change outside gear shift controls the selection. Auxiliary units, such as immersion pans, idler rolls, spreaders, entering units, compensator or folder, are accommodated by the standard machine. Splash guarding and effluent control are important features in the design. The machine is readily adapted to either individual or range use, and it is equipped with lifting lugs in order to facilitate materials handling.

APPLICATIONS——The use of the Niptrol for continuous extraction is obvious, but its application to starching and resin or dye padding possibly calls for further discussion.

This machine will take cotton goods wet from the bleach house and extract and starch in a single pass. The primary nip will extract goods thoroughly and uniformly enough so that starch solution may be applied continuously and extracted in the lower pressure of the rear secondary nip.

Resins may be effectively applied by the Niptrol mangle to many fabrics. The fabric is threaded so that it is immersed in resin and passed through the front secondary nip in an upward direction. Resins are padded into the fibers uniformly from selvage to selvage. Coming out of the nip the fabric expands immediately, without contacting air, into a puddle of resin, which collects between the support roll and the "soft" roll. This expansion effect causes the resin to be drawn into the fibers, resulting in effective impregnation. The fabric is then re-immersed in resin and passed through the sharp primary nip to remove excess surface resin, which is returned to the bath. Chemical consumption is markedly reduced, the hand finish and quality of the fabric are said to be exceptional, and surface deposition of resin is avoided. The surface characteristics and pressure of the soft roll are such that even if a spun rayon fabric accidentally entered the nip folder or creased it would not be damaged.

For dye padding, the Niptrol offers exceptional pickup and penetration of the inner fibers, plus economical use of dyestuff with the sharp final nip and complete recovery system. And the single full-width pneumatic tube automatically insures evenly distributed nip loading.

With the Niptrol, mercerizing can be done on wet goods. The machine can also be used after mercerizing for additional extraction to expedite drying, thereby accounting for substantial savings in time and steam.

SUMMARY——The novel pneumatic method for equalizing pressure combined with the extraordinary characteristics of the soft roll makes the Niptrol Pneumatic Mangle fully suited for processing fabrics of cotton, linen, wool, acetate, or viscose filament, acetate-viscose blends, nylon, spun rayon, and other new synthetics.

GENERAL CALENDAR

AMERICAN CHEMICAL SOCIETY
National Chemical Exposition—Oct 12-15, Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
Southern Textile Conference—Nov 4-5, North Carolina State College, Raleigh, N C.

AMERICAN SOCIETY FOR QUALITY CONTROL
Annual meeting, Textile Div—Jan 27-29, Clemson College School of Textiles.

DELTA KAPPA PHI FRATERNITY
1955 Annual Convention—April 29-30, Lowell, Mass.

DEUTSCHE GESELLSCHAFT FÜR CHEMISCHES APPARATEWESEN
Achema XI—May 14-22, Frankfurt am Main, Germany.

DRYSALTERS CLUB OF NEW ENGLAND
Oct 29, Jan 24, April 29 (Hotel Vendome, Boston, Mass); June 24 (Outing—Wachusett Country Club, W Boylston, Mass.)

Spring Meeting—May 4-5, 1955, Alabama Polytechnic Institute, Auburn, Alabama.

Fall Meeting—Sept 8-9, 1955, Massachusetts Institute of Technology, Cambridge, Mass.

INTERNATIONAL TEXTILE EXHIBITION
2nd Exhibition—June 25-July 10, 1955, Brussels, Belgium.

INTERNATIONAL WOOL TEXTILE RESEARCH CONFERENCE
September, 1955—Sydney, Melbourne, and Geelong, Australia.

NATIONAL ASSOCIATION OF HOSIERY MANUFACTURERS, KNITTED OUTERWEAR ASSOCIATION, THE UNDERWEAR INSTITUTE
42nd Knitting Arts Exhibition—April 25-29, Convention Hall, Atlantic City, N J.

NATIONAL COTTON COUNCIL OF AMERICA
1954 Chemical Finishing Conference—Oct 7-8, Hotel Statler, Washington, D C.

Annual Meeting—Jan 31-Feb 1, Hotel Shamrock, Houston, Tex.

Cotton Research Clinic—Feb 16-18, Pinehurst, N C.

NATIONAL INSTITUTE OF DRYCLEANING
4th Educational Conference—Dec 5-10, Silver Spring, Md.

NEW YORK PIGMENT CLUB
Oct 14, Nov 10, Dec 9, Jan 15.

NORTH CAROLINA TEXTILE MANUFACTURERS ASSOCIATION
48th Annual Meeting—Oct 14-15, The Carolina, Pinehurst, N C.

SOUTHERN TEXTILE EXPOSITION
October 4-9 (Textile Hall, Greenville, S C).

TEXTILE RESEARCH INSTITUTE
25th Annual Meeting—March 10-11, Hotel Commodore, New York, N Y.

• NEWS OF THE TRADE •

• Allied Chemical Dedicates New Lab

Allied Chemical & Dye Corporation dedicated the large new Research Laboratory for its General Chemical Division in Morris Township, New Jersey, on Sept 8 with a simple open house. A large number of public officials, laboratory employees and their wives, and company executives attended the affair.

Members of the laboratory supervisory staff conducted the guests on guided tours of the two-million-dollar facility, which is reported to be one of the most extensive and completely equipped industrial research laboratories in the New York area. With the completion of this research center, adjacent to the company's Central Research Laboratory, every division of Allied Chemical will have added new research laboratories since the end of the war.

The three-story L-shaped building provides over 55,000 square feet of floor space for research activities. Included are more than 30 laboratories of various types, a technical library, and engineering research offices, as well as a special section for work with radio-active substances, an extensive analytical suite with modern spectrographic, optical, and physical testing equipment, and an agricultural formulating and milling laboratory.

According to a company spokesman, the new laboratory will permit General Chemical Division to expand and intensify its diversified laboratory research program in industrial, scientific and agricultural chemical fields. It replaces the Division's Laurel Hill, Long Island, N Y, laboratory, which was one of the first major chemical research centers in the country.

The new laboratory's activities will be coordinated with related phases of the Corporation's extensive central research program as well as with large-scale development and pilot plant research conducted at General Chemical's other laboratories in Baton Rouge, La, and at Marcus Hook, Pa.

Dr J H Pearson, a member of the General Chemical research staff for the past 18 years, is director of the laboratory.

STILL GROWING———The 18th biennial Southern Textile Exposition in Greenville, S C, Oct 4-8, will be bigger than ever before, with 280 manufacturers of machinery, equipment and supplies exhibiting. A new brick and steel annex of 14,000 square feet has been added to Textile Hall in time for the 1954 show. It can be seen above, the farthermost building at the end of the driveway.

• 8th New England Conference, ASQC

The Eighth New England Conference of the American Society for Quality Control will be held at the Ten Eyck Hotel, Albany, N Y, Oct 21-23.

A new feature of the conference will be a management seminar on quality control conducted by three industrial consultants in this field. Clinical sessions, educational programs, and factory visitations also have been arranged.

The Northern Regional Meeting of ASQC's Textile Division will be held in conjunction with the Conference.

For additional information write to Southern Connecticut Section, ASQC, Box 1681, Bridgeport 1, Conn.

• Sagamore Address Change

Sagamore Color & Chemical Co has moved to new quarters at 82 Braintree St, Boston 34, Mass (Allston Station). The new phone: ALgonquin 4-8870.

Front view of Allied Chemical & Dye Corporation's newest research laboratory at Morris Township, N J.

OBITUARY

Frank H Ross, Sr

FRANK H ROSS Sr, president and founder of F H Ross & Company, Charlotte, N C, passed away at the Presbyterian Hospital, Charlotte, N C, on August 19th after having been in declining health for several months.

He was born in Charlotte on June 16th, 1884 and received his education in the Charlotte City Schools and University of North Carolina. His business career began with the Cudahy Packing Company, with which he was affiliated until he founded F H Ross & Company in 1920. He remained its president until the time of his death. Under his direction the company was expanded from one operation to thirteen offices and warehouses.

Mr Ross was a director of the Union National Bank of Charlotte, the Charlotte Country Club and the Lawton, Oklahoma Coca-Cola Bottling Company; and was a member of the Charlotte City Club, Myers Park Presbyterian Church and American Association of Textile Chemists and Colorists.

● ABSTRACTS ●

Cellulose Acetate as a Raw Material for Rayon Production

A R Urquhart, *Dyer* 111, 831, 833, May 28, 1954.

The manufacture of cellulose acetate by acetylating cellulose to a higher degree than that required, and completing the process by hydrolyzing some of the acetyl groups, is probably more difficult and certainly more expensive than the production of viscose from cellulose, but the subsequent formation of the rayon from acetate is much less complicated than the formation of rayon from viscose.

Because of the advantage of a much greater rate of production (said to be from four to ten times that normally obtained in viscose spinning), acetate rayon has been able to compete with viscose rayon in spite of much greater material cost.

Comparing acetate rayon with viscose rayon, the author stated that the former absorbs less moisture and in consequence loses less strength when wet. The fact that the acetate rayon is not dyed by ordinary cellulose dyes is valuable in permitting the production of differential dyeing effects. In addition, the luster of acetate rayon may be altered at will by suitable finishing treatments. But the widespread acceptance of this fiber, according to the author, is much more attributable to its lower susceptibility to creasing and to its hand and draping qualities.

Discussing possible competition from the synthetic polymers, particularly Terylene and Orlon, the author stated that at present there is no indication that the price of these new fibers is even beginning to approach that of acetate rayon.

Quick drying of a fabric after washing is a property much sought at present, but the author pointed out that this depends essentially on low moisture absorption by the fiber, and considerations of hygiene and comfort demand that clothing, particularly underwear, shall be capable of absorbing appreciable amounts of water. In this respect, none of the synthetics compare with the cellulose rayons.

The author also discussed possible changes in the structure of acetate rayon by altering the spinning conditions. For example, cross-sections of "ham bone" shape have been used to make a very voluminous yarn. Also, by stretching the fiber when plastic, very strong yarns have been produced.

Discussing the degree of polymerization, the author stated that cellulose has a very high chain-length, probably between 1000 and 3000 glucose units, but in the manufacture of acetate rayon much degradation occurs, so that the mean chain-length of the ultimate fiber is only about 200-300 glucose units. He said that it is possible to produce acetate fibers that are actually stronger than cotton fibers, even though the molecules are only one-tenth as long. The reason is that the strength of the fiber depends much less on chain-length than on arrangement of the molecules in the fiber.—WHC.

Problems in Dyeing the Newer Synthetic Fibers

I M S Walls, *Textile Mfr* 80, 157-8, March, 1954. (Presented at a Conference of the Textile Institute.)

In a study of the dyeing properties of any new fiber the first problems must always be "which dyestuffs have a satisfactory affinity for this fiber?". This problem has had to be faced with all the new synthetic fibers since acetate rayon was produced, but it is interesting to note that since the disperse dyes were devised to dye that fiber it has not been thought necessary to develop any other totally new type of dyestuff solely to meet the requirements of a more recent fiber. This is really a tribute to the versatility of the disperse dyes, which are the most generally useful colors for most of the synthetic fibers from acetate rayon onwards. Nylon, Terylene, Orlon and Dynel are all commonly dyed by these dyes.

Nylon and the other polyamide fibers may be described as readily dyeable fibers in that they have quite high affinities for most classes of dyes. Terylene is not a readily dyeable fiber. Both acetate rayon and Terylene contain a multiplicity of ester groups, and dyeing is limited to the same classes of dyes, i e, disperse colors for most purposes, with azoic colors, applied by the "modified azoic" technique, uesd for medium to heavy shades of improved fastness properties.

Orlon and Dynel can both be dyed by disperse colors to a wide range of shades of good washing fastness and moderate to good light-fastness. Orlon has a high affinity for basic dyes which have very good wet-fastness properties on this fiber and, using selected dyes, light-fastness which is not far below that of the disperse dyes. The most interesting technique devised for dyeing these fibers, however, is the cuprous ion method which produces shades of excellent wet-fastness and good to very good light-fastness.

On the bulk scale this technique has not proved to be very popular, since when using it there are so many factors to be considered, e g, the quantities of copper sulfate and reducing agent required, the pH of the dyebath, and the dyeing temperature. The reproducibility of the shades dyed by the cuprous ion technique is not always good, and shade matching is not easy. If level dyeings are to be produced, the dyeing process must be very carefully controlled, and so far it seems to have been largely restricted to the dyeing of yarn or loose material.

The modified polyacrylonitrile fibers such as Acrilan are readily dyed, most of them having been chemically modified so that they have affinity for acid dyes and sometimes vat dyes.

Most of the synthetic fibers have two characteristics in common. They are hydrophobic with low moisture regains, and the fiber molecules are highly orientated and tightly packed, much more so than in natural fibers.

Carrier dyeing may be considered first, since it is the more widely practised. One of the principal functions of carriers is to swell the fiber by pushing some of the fiber chains apart and enlarging the spaces into which dye molecules may penetrate.

High temperature dyeing, which offers an alternative method of enabling the dye to penetrate the fiber, has, however, several advantages to offer. When the temperature of the dyebath is raised, the fiber molecules gain energy and move about more vigorously. When dyeing under pressure at temperatures of 115-120°C the rate of dyeing seems to be faster than that which can be achieved at the boil with carriers, and this means that certain slower dyeing dyes can be used at the high temperature while they remain unsatisfactory at the boil. One advantage of high-temperature dyeing, therefore, is that it widens the range of dyes that may be used. Further advantages are that the greatly increased rate of dyeing enables the dyeing time to be considerably reduced, and that the leveling of some dyes is improved.

High-temperature dyeing under pressure will not be equally important for all of the newer fibers. Orlon staple fiber, however, is one fiber that benefits considerably by pressure dyeing, since disperse and particularly basic dyes build up to heavier shades of improved fastness properties under such treatment. Orlon continuous filament yarn demands pressure dyeing if medium to heavy shade are to be achieved, since only pale shades can be obtained at the boil, even if carriers are used.

Terylene is another fiber for which pressure dyeing is eminently suitable, heavy shades being readily obtained by this method and much better exhaustion obtained.—WHC.

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